



Chicago Metropolitan
Agency for Planning

233 S. Wacker Drive, Suite 800
Chicago, IL 60606

www.cmap.illinois.gov

voice 312-454-0400

fax 312-454-0411

FREQ Simulation and Ramp Meter/HOV Bypass Optimization

for the Northwest Study Area

June 2008

CMAP Congestion Management Process

Author: Jose Rodriguez

Project Manager: Tom Murtha

**FREQ Simulation and
Ramp Meter/HOV Bypass Optimization
for the
Northwest Study Area**

June 2008

By

Jose Rodriguez
Chicago Metropolitan Agency for Planning (CMAP)

Kazuya Kawamura
Amir Samimi
University of Illinois at Chicago

Prepared By:

Jose Rodriguez, Associate Planner, Chicago Metropolitan
Agency for Planning (CMAP)

Kazuya Kawamura, Associate Professor, University of Illinois at
Chicago (UIC) Urban Transportation Center

Amir Samimi, Doctoral student, University of Illinois at
Chicago (UIC) Urban Transportation Center

Abstract:

The I-290 / Illinois Route 53 corridor in the west and northwest suburban areas of Chicago suffers from heavy congestion throughout and beyond peak travel periods. Traffic management strategies, particularly ramp access strategies prioritizing high occupancy vehicle (HOV) travel, have been recommended as a means of mitigating and even reducing congestion in this corridor. The FREQ model developed by the University of California, in part assisted by the VISSIM modeling tool for bottleneck calibration, was used to determine the effect of implementing HOV priority strategies on entry ramps along the I-290 / IL 53 corridor.

FREQ model inputs were based on available historical and forecasted traffic data and network parameters. Several ramp meter and ramp HOV priority bypass scenarios were tested to determine potential year 2030 improvements in several performance measures from the forecasted 2030 base conditions.

Findings derived from application of these various scenarios indicated net *reductions* from 2030 base in: passenger-hours of travel (PHT) ranging from 2.0% to 15.4%, and tons of volatile organic compounds (VOCs) emitted from 2.4% to 13.5%. Vehicle-miles traveled (VMT) and gallons of fuel consumed remain relatively constant across scenarios.

In addition to the results of the FREQ analysis, present-day expressway and arterial highway design characteristics that adversely impact vehicle capacity and queue storage capability of ramps are identified and explained.

Table of Contents

List of Figures	9
List of Tables	11
I. Purpose and Need	13
HOV Lane Concept Overview	14
II. Background	18
Study Area	18
Scope of the Study	21
Modeling Strategy	22
Figure 9 depicts the overall strategy for assessing the potential benefit of ramp metering strategies for the study corridor.	22
III. Simulation and Calibration	24
Input data	24
VISSIM simulation	25
Calibration	28
IV. Alternate Scenarios	36
Growth rates	37
Spatial shift	37
Modal shift	37
Optimization of ramp metering rates	37
Simulation Parameters	38
V. Findings	38
Ramp metering without HOV priority entrance (PE)	38
Ramp metering with HOV priority entrance	43
Ramp metering with HOV priority entrance with bus service	48
VI. Conclusion	50

Appendices

Appendix 1: VISSIM Modeling	ii
Appendix 2: Calibration Data	xii
Appendix 3: Simulation Results	xxxii
Appendix 4: FREQ Analysis Graphics for All Directions and Times	xlii

List of Figures

Figure 1	Aggregated VMT – I-290 / IL 53 EB/WB: Lake Cook Rd to Wacker Dr...	13
Figure 2	Design Diagram, Metered Freeway Ramps with HOV Priority Entry Lane	15
Figure 3	Photo of Cloverleaf On-Ramp with HOV Priority Entry Lane	16
Figure 4	Photograph, HOV Priority Entry Lane alongside Metered Lane, Entry	
	Ramp to southbound I-515 from Cheyenne Road, Las Vegas NV.....	16
Figure 5	Sketch Diagrams: Expressway On-Ramp without Right Turn Only Lane and with Right Turn Only Lane	17
Figure 6	Study Area	19
Figure 7	Parallel Arterials	20
Figure 8	2002 to 2007 Traffic Growth for Selected Locations	22
Figure 9	Overview of FREQ and VISSIM Modeling Strategy	23
Figure 10	2002 Base Condition – Outbound AM Simulation.....	32
Figure 11	2002 Base Condition – Outbound PM Simulation	32
Figure 12	2002 Base Condition – Inbound AM Simulation	35
Figure 13	2002 Base Condition – Inbound PM Simulation	36
Figure 15	2030 with Ramp Meters without Spatial Shift - Inbound AM.....	40
Figure 16	2030 with Ramp Meters with Spatial Shift - Inbound AM.....	41
Figure 17	2030 Base Condition - Outbound PM.....	41
Figure 18	2030 with Ramp Meters without Spatial Shift - Outbound PM	42
Figure 19	2030 with Ramp Meters with Spatial Shift - Outbound PM.....	43
Figure 20	2030 with Ramp Meters with PE with Spatial Shift - Inbound AM.....	44
Figure 21	2030 with Ramp Meters w/PE with Spatial/Mode Shift - Inbound AM.....	44
Figure 22	2030 with Ramp Meters with PE with Spatial Shift - Outbound PM.....	47
Figure 23	2030 with Ramp Meters w/PE with Spatial/Mode Shift - Outbound PM.....	47
Figure 24	2030 w/Ramp Meters w/PE w/Spatial and Mode Shift, w/Bus Service --- Inbound AM.....	49
Figure 25	2030 w/Ramp Meters w/PE w/Spatial and Mode Shift, w/Bus Service --- Outbound PM.....	49

List of Tables

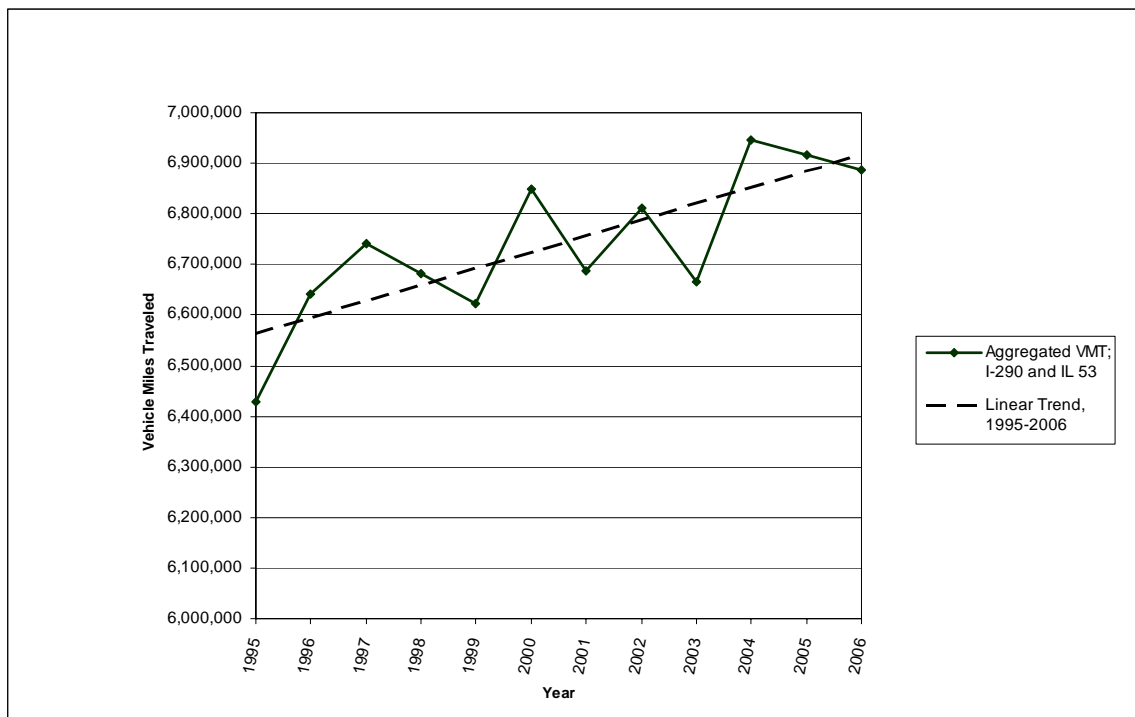
Table 1. List of Parallel Arterials.....	20
Table 2. Weaving Section Capacities Estimated Using VISSIM	27
Table 3. Section numbers lookup table – Inbound	30
Table 4. Section numbers lookup table – outbound.....	31
Table 5. Simulation Results - 2030 Ramp Metering without Priority Entrance	39
Table 6. Simulation Results - 2030 Ramp Metering with Priority Entrance	44
Table 7. Simulation Results for Arterial and for combined Mainline, Ramp & Arterial, 2030 Ramp Metering with Priority Entrance.....	46
Table 8. Simulation Results- 2030 Ramp Metering w/ Priority Entrance / Bus Service.	48

I. Purpose and Need

A report by American Highway Users Alliance, a non-profit transportation advocacy group based in Washington D.C. ranked the sections between Exit 17b (U.S. Route 45 or Mannheim Road) and Exit 23a (Illinois Route 50 or Cicero Avenue) of the I-290 Interstate Expressway as the 19th worst bottleneck in the nation (American Highway Users Alliance, 2004). The report also estimates that without any improvement, the delay¹ at the aforementioned bottleneck will increase from 14.4 minutes in 2002 to 19.2 minutes by 2025 (page 56). In regards to truck traffic, I-290 features two of the nation's 20 worst truck traffic bottlenecks – at the downtown I-90/94 “Spaghetti Bowl” junction (4th worst) and at the merge with I-355 in northeastern DuPage County (17th). The two bottlenecks combined for 6.94 million hours of travel delay in calendar year 2005 (FHWA Highway Interchange Bottlenecks National Study, 2005).

Total VMT reported for both directions of the three segments comprising the corridor – I-290, Eisenhower Expressway, between the Chicago CBD and I-88/I-294, the Eisenhower Extension of I-290 between the I-88/I-294 interchange and the Jane Addams Tollway and IL 53 between the Jane Addams Tollway and Lake Cook Road are listed below:

Figure 1 Aggregated VMT – I-290 and IL 53 EB and WB: Lake Cook Rd to Wacker Dr



¹ The difference in travel time between free-flow and congested conditions.

During this same period, only 16 lane miles have been added to this corridor during the same period: an additional local lane between the I-294 SB ramp and 25th Avenue (4 miles) with a corresponding additional auxiliary lane from 25th Ave to Wolf Rd (2 miles), and an additional lane both EB and WB added in 2003-4 along the 5 mile stretch (10 miles) from I-90 south to I-355.

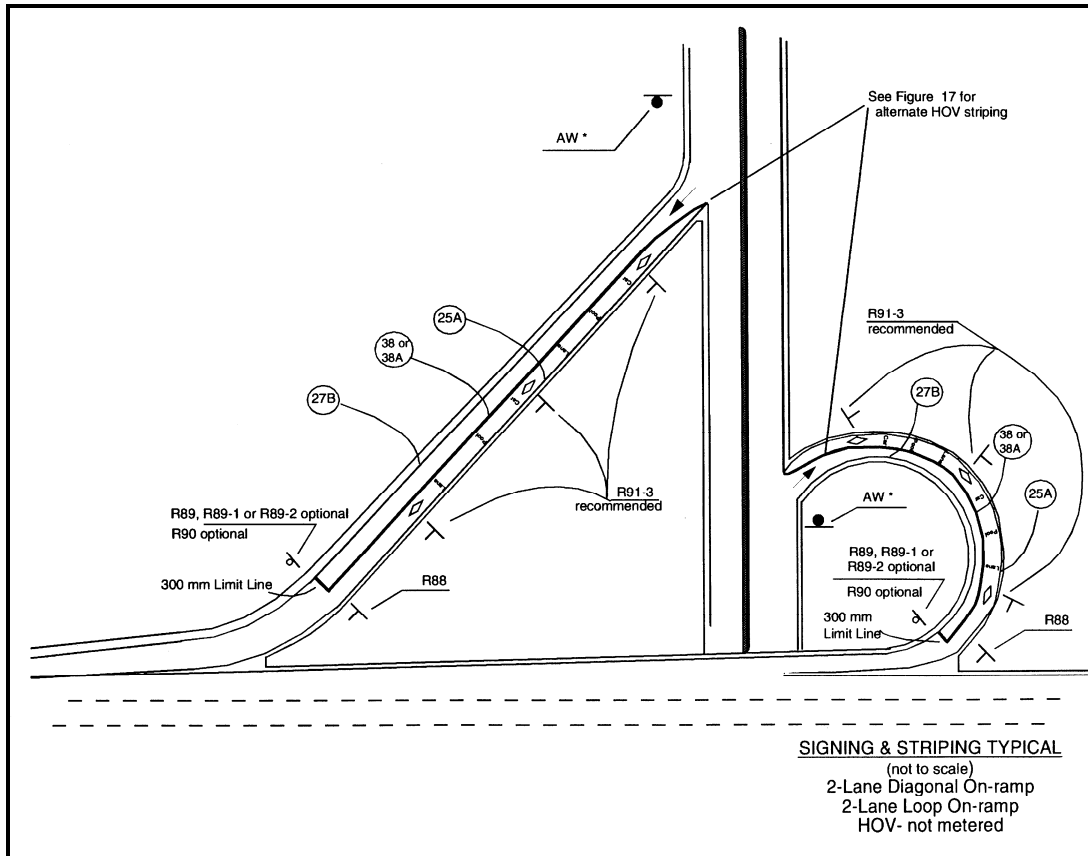
While lane additions, the most direct remedy, will certainly provide additional capacity and relief congestion, there are traffic management strategies that have been successfully adopted in other parts of the country to achieve the same goal. The overarching purpose of this study is to assess the effectiveness of traffic management strategies, specifically, the installation of ramp meters with and without HOV bypass lanes, for the I-290 corridor.

HOV Lane Concept Overview

HOV bypass lanes, or HOV priority entry (HOV PE) shall first be distinguished from the more commonly discussed expressway HOV Lane strategy. An HOV Lane is a marked through expressway lane dedicated to use solely by high occupancy (2+ or 3+ occupant) passenger vehicles, commuter vans or buses. In recent years, to combat the negative perception of “empty lanes” serving the few vehicles that had more than one occupant and to maximize the vehicle carrying capacity of HOV lane facilities, several state and local transportation entities have made access to HOV lanes available to drive-alone (or SOV) vehicles paying a toll (High Occupancy Toll, or HOT, Lanes) or to vehicles producing significantly lower emissions such as motorcycles or hybrids.

HOV PE or HOV bypass lanes refer specifically to the mechanism on the expressway entrance ramp allowing HOV passenger or transit vehicles unimpeded access, in one lane, to the expressway merge. Entry of SOV vehicles is metered by a traffic signal device in a parallel lane on the ramp. The premise of this strategy is to manage the flow of traffic entering into an expressway by the level of person throughput. The flow of automobiles through a section of a freeway reduces significantly when the traffic reduces to stop-and-go condition. Ramp meters, when correctly operated, increases traffic throughput by preventing the stop-and-go condition from occurring by regulating the flow of automobiles onto freeway sections. The highest throughput is normally achieved at the volume-to-capacity (V/C) ratio slightly below 1.0. If applied correctly, ramp meters can improve the operating efficiency of an expressway by achieving the V/C near 1.0 while preventing the break down.

Figure 2 Design Diagram, Metered Freeway Ramps with HOV Priority Entry Lane (Left Lane)



Source: FHWA, Ramp Management and Control Handbook

Figure 3 Photo of Cloverleaf On-Ramp with HOV Priority Entry Lane



Source: FHWA, Ramp Management and Control Handbook

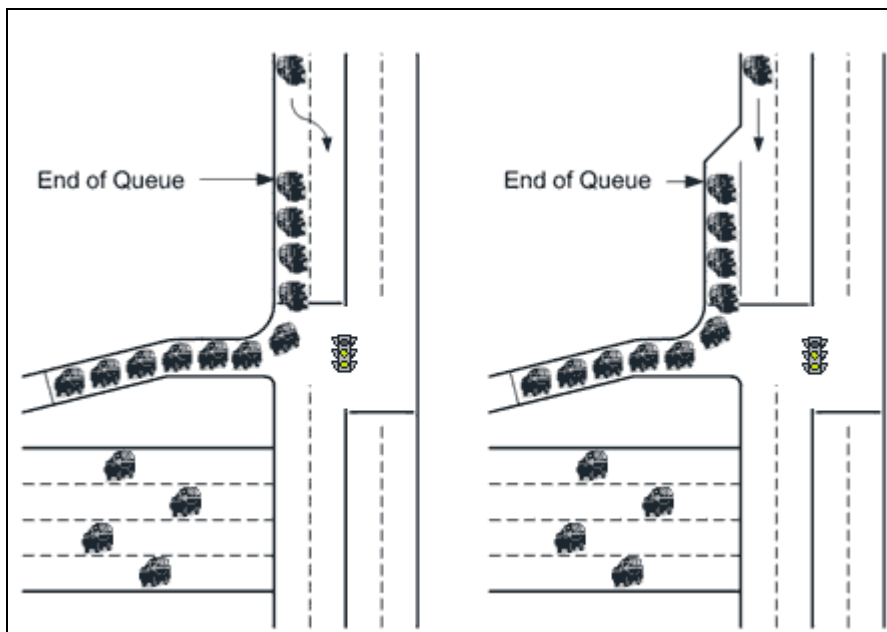
Figure 4 Photograph, HOV Priority Entry Lane alongside Metered Lane, Entry Ramp to southbound I-515 from Cheyenne Road, Las Vegas NV.



Source: Regional Transportation Commission of Southern Nevada

The desired outcome is a lower number of vehicles carrying a higher number of persons on the mainline expressway. Ramp metering, HOV PE in particular, is also expected to encourage carpooling or transit use in order to take advantage of the improved expressway facility. However, traffic volume and congestion of traffic flow on ramps and on crossing and parallel arterial roads may be increased through application of the ramp meters. The ability of the arterial system to accommodate diverted traffic flows depends a great deal on the capacity available for queued vehicles at ramp junction intersections. This relationship is borne out by the following “before” and “after” sketch diagrams of a standard diamond-style on-ramp without and with a right turn only lane access.

Figure 5 Sketch Diagrams: Expressway On-Ramp without Right Turn Only Lane and with Right Turn Only Lane



Source: [FHWA, Ramp Management and Control Handbook](#)

Furthermore, ramp meters are known to reduce accidents. Minnesota DOT turned off 430 ramp meters along its expressway systems in the Twin Cities region for seven weeks in 2000. During this period travel times increased, crashes increased by 26% and volume on affected freeways decreased by 14%. Immediately subsequent, the ramp meters were returned to full operation. (Cambridge Systematics, 2001). Since delays caused by incidents account for 50% or more of total congestion in urban areas (Transportation Research Board, 2001), reducing accidents will lead to a decreased level of congestion.

While ramp metering is not the only option to improve the traffic flow along the I-290 corridor, its history of successes in other areas such as California, Minneapolis, Texas, and Milwaukee (USDOT, 1995, Cambridge Systematics, 2001), makes it a strong candidate that warrants an assessment of its applicability.

II. Background

This study of the I-290 corridor is comparable in format, simulation methodology, analysis and presentation of achieved benefit results to the extensive FREQ study of the South Study Area – Dan Ryan, Bishop Ford Freeway and I-57 – by CMAP staff in 2001 (Doenges, 2001). This study builds on the previous effort by CMAP staff that developed the FREQ simulation model for the I-290 corridor (Schermann, 2005).

This report documents additional work that has been performed by Kazuya Kawamura and Amir Samimi of the Urban Transportation Center at the University of Illinois, Chicago under the direction of Jose Rodriguez and Thomas Vick of CMAP². The work included:

- Data preparation and coding of the sections between Austin Avenue Interchange and Independence Boulevard Interchange
- Identification, data preparation, and coding of parallel arterials
- Data preparation and coding of VISSIM simulation for the I-88/I-294/I-290 Interchange
- Calibration, optimization, and simulation of existing conditions and future scenarios
-

A more detailed documentation of the work performed by the UIC team and detailed output from the simulations are included in the Appendix.

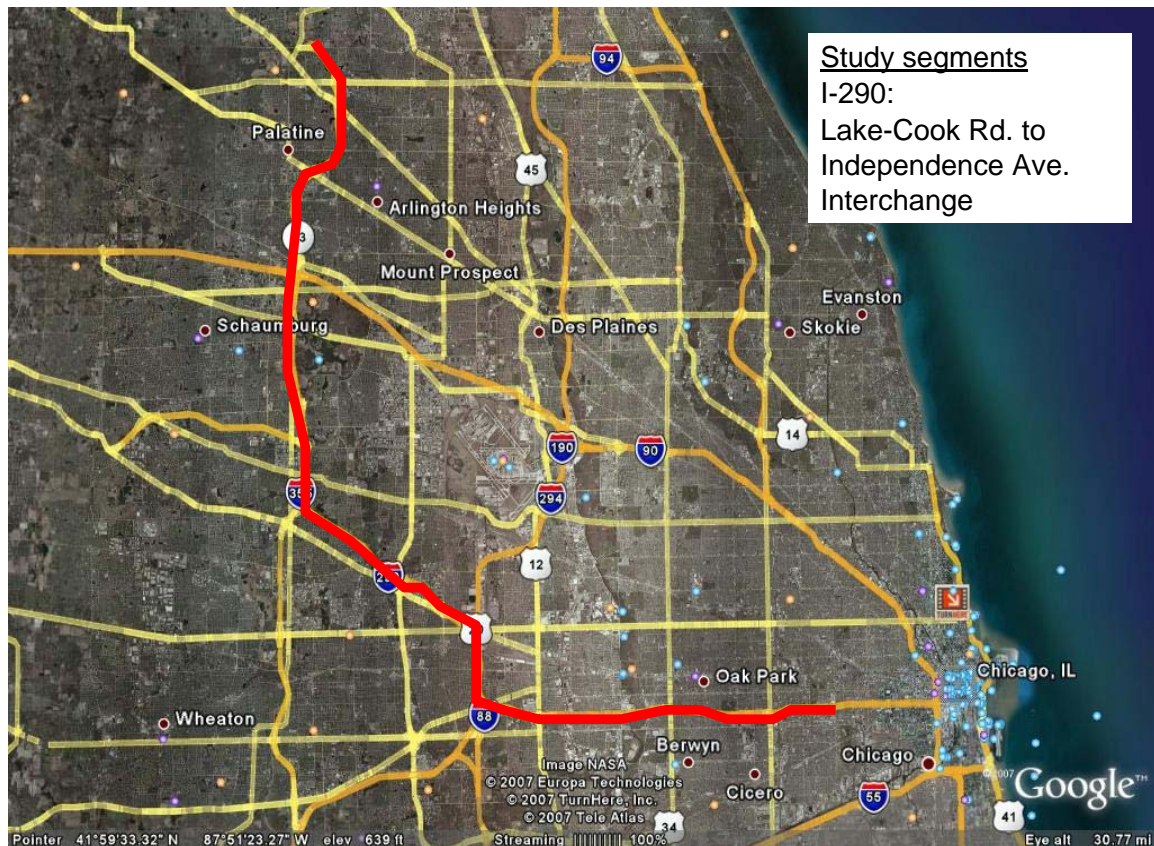
Study Area

The study area includes the sections of I-290 Expressway from Independence Avenue Interchange in Chicago to the Illinois Route 53 (IL 53) merge at Lake-Cook Road (see Figure 6). This study builds on the previous effort by CMAP staff that developed the FREQ simulation model for the I-290 corridor (Schermann, 2005). In the working paper by Schermann (2005), the study area was described as between Austin Avenue interchange and Lake-Cook Road. However, the speed profiles for the I-290 for 2003³, obtained from the IDOT detectors report, indicated that the congestion for the westbound traffic extends beyond the Austin Avenue interchange. The detector report indicated that in general, congestion does not extend beyond the Independence Boulevard interchange except for the most congested hours in the afternoon. Ideally, the study area should be extended all the way to the I-90/94 interchange to account for the entire extent of the congestion. Unfortunately, the limitation in resources prevented the study team to extend the study area beyond the Independence Boulevard interchange.

² Vick retired from CMAP in November 2007, but provided input to the report.

³ The data were collected for selected Tuesdays and Thursdays in November and December of 2003

Figure 6 Study Area



Parallel Arterials

A set of arterials that are potential diversion routes to the I-290/IL 53 corridor has been identified and included in the simulation. FREQ considers two distinct types of route diversion (called “spatial response”) possibilities that will be discussed later in this report. In FREQ, both types of spatial diversion assume that the trip origin is within the FREQ study area. Thus, FREQ does not simulate the route diversion for the trips that are merely passing through the corridor (i.e. both origin and destination outside the study area).

One additional point worth mentioning is that FREQ does not simulate each of the individual surface streets separately as a potential diversion route. Rather, all the potential diversion routes are bundled together to form, in essence, a “parallel corridor”. Thus, the input for the parallel corridor must represent the aggregate characteristics of a combination of all the potential surface streets that are potential diversion routes.

With these assumptions in mind, a set of surface streets shown in

Table 1 and Figure 6 were chosen as potential parallel arterials. The basic criteria for selection were that the surface street:

- has sufficient capacity to accommodate diverted trips
- runs parallel to the I-290/IL53 for at least 3 miles
- is in the vicinity of the I-290/IL53 and is a known alternative route.

Figure 7 Parallel Arterials

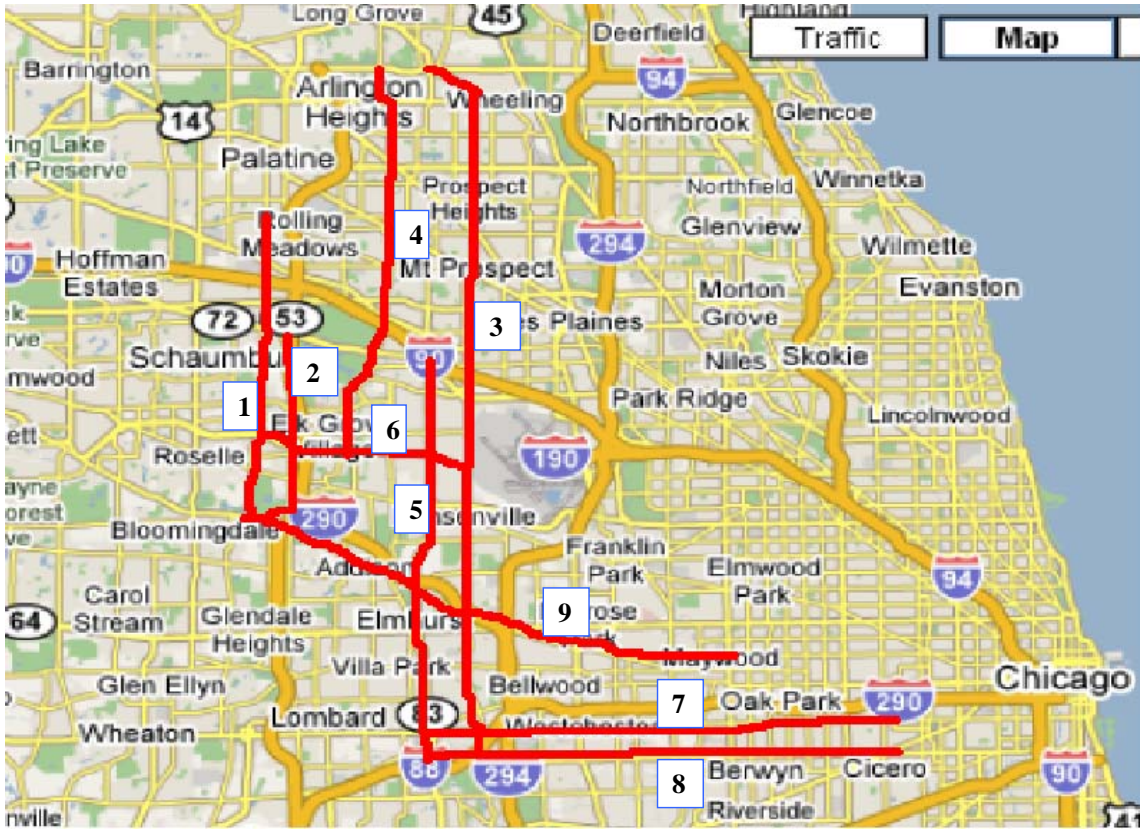


Table 1. List of Parallel Arterials

1. Meacham/Medinah (from Euclid Ave. to Lake)
2. Rohwling/Martingale (from Higgins Rd. to Lake St.)
3. Elmhurst Rd./York Rd. (from Lake-Cook to Cermak)
4. Arlington Heights Rd. (from Lake-Cook to Thorndale)
5. IL-83/Busse/Kingery (from Algonquin to Cermak)
6. Thorndale/Elgin-O'Hare (from Meacham to York)
7. Roosevelt (from Kingery Hwy to Eastern terminus)
8. Cermak (from Kingery Hwy to Eastern terminus)
9. US-20/Lake (from Medinah to Harlem)

Since the study corridor bends 90 degrees, a combination of north-south and east-west streets had to be considered as a potential diversion route. For example, Rohwling Road/Martingale Road together with US20/Lake Street forms a diversion route that may provide significant travel time saving although they may not qualify as individual routes.

Scope of the Study

The overarching goal of this study was to determine the traveler (passenger), system (VMT), and environmental (VOCs and gallons of fuel reduced) benefits achieved through an expressway corridor application of HOV ramp priority entry. Given the wider ranging impacts on the surrounding arterial system and the inclusion of an extensive alternate arterial network, a meso-scopic simulation model capable of integrating data elements from a larger area than a corridor was needed for this analysis. Meso-scopic simulation models are also less labor and data intensive than standard microscopic simulation models which require large volumes of custom prepared data focused on a single corridor.

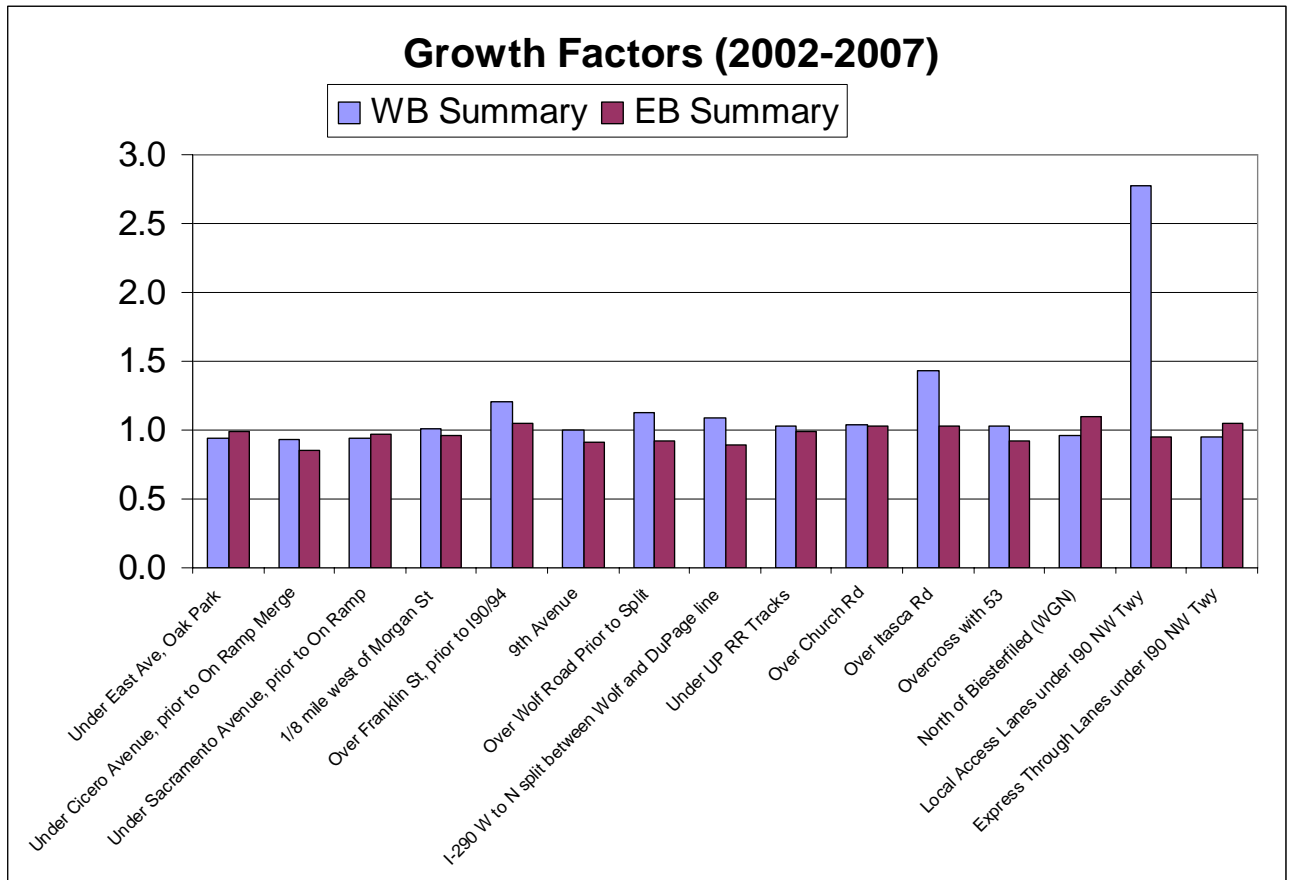
FREQ was originally developed by the University of California at Berkeley's Institute of Transportation Studies for use by the California Department of Transportation (Caltrans). The model was originally created in 1970 to be used as a tool to evaluate an improvement plan on a 140-mile segment of expressway in the San Francisco area. FREQ is currently in its 12th version and has been improved to evaluate the effect of implementing HOV facilities on an expressway system.

The FREQ model works on "pipeline" theory and generates synthetic origin-destination (O-D) trip tables based on traffic count data entered by the user into the model; the specific user inputs are explained below in Section III, Input Data. The FREQ model is capable of two types of general analyses: (1) priority lane (PL) to examine the effect of mainline HOV lanes or (2) priority entry (PE) to examine the effect of on-ramp HOV bypass lanes (Doenges, 2001). For the purpose of this study the FREQ PE model was used.

Preliminary work for FREQ modeling has been completed by the CMAP staff between 2001 and 2003. Detailed descriptions of the methodologies used to generate the input traffic volumes for both the mainline and ramps are included in the aforementioned CATS working paper (Schermann, 2005). In addition to the preparation of the input dataset, a preliminary calibration was performed for the inbound simulation. However, the process and assumptions were not documented in detail, and it was not possible to utilize their work for this study.

One critical assumption that was inherited from Schermann's work is the base year of simulation. As was for the Schermann's work, March of 2002 was used as the base year for the traffic volumes. This is justified by the fact that traffic volumes for the I-290/IL53 corridor have been generally stable between 2002 and 2007 as shown in Figure 8.

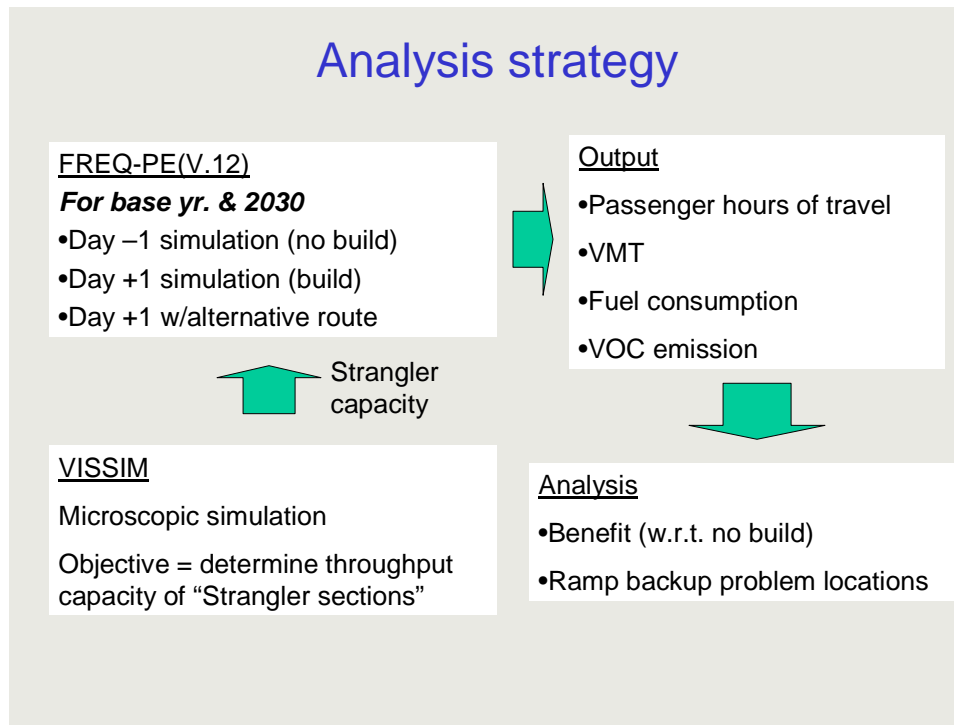
Figure 8 2002 to 2007 Traffic Growth for Selected Locations



Modeling Strategy

Figure 9 depicts the overall strategy for assessing the potential benefit of ramp metering strategies for the study corridor.

Figure 9 Overview of FREQ and VISSIM Modeling Strategy



VISSIM Simulation

One of the weaknesses of the FREQ program is its analysis of weaving sections. FREQ estimates the capacity of weaving sections using the method from the 1965 Highway Capacity Manual. As such it is not fully capable of analyzing complex weaving sections such as the I-290/I-88/I-294 interchange. To address this shortcoming, a micro-simulation model was developed for the I-290/I-88/I-294 interchange using the VISSIM software to obtain an accurate estimate of the capacity.

VISSIM is a simulation tool that can be used to study the operation and behavior of complex roadway sections and also interrupted flow conditions. As the development of VISSIM simulation is an extremely labor and data intensive endeavor, only the I-290/I-294/I-88 Interchange was simulated. The development of the VISSIM simulation is discussed in the next section of this report.

Expanded Meso-Scopic Simulation

The FREQ analysis findings have additional importance as they may be used in estimating performance measures (or measures of effectiveness) data when ramp metering and HOV bypass strategies are considered by decision makers. Effects of ramp strategy implementation within FREQ can be inputted as appropriate algorithms in broader regional meso-scope models used to evaluate effectiveness of ramp improvements made to links or series of links (e.g. corridors) in the regional travel network. Meso-scope simulation models have the advantage of incorporating and

utilizing actual O-D tables derived from aggregated regional traffic and demographic data. The adaptation of this report's FREQ findings on the I-290 corridor into mesoscopic simulation models for short-term and long-range strategy evaluation is envisioned as a next logical activity.

III. Simulation and Calibration

This section describes the methodology and assumptions used to carry out the development of the FREQ simulation.

Input data

The FREQ simulations were conducted for the following four time periods, each covering 8 hours.

- Inbound AM travel period (4:00AM – 12:00 Noon)
- Inbound PM travel period (12:00 Noon – 8:00 PM)
- Outbound AM travel period (4:00AM – 12:00 Noon)
- Outbound PM travel period (12:00 Noon – 8:00 PM)

It should be noted that AM and PM simulations were conducted independently. Thus, the traffic condition at the end of the AM simulation does not necessarily match the starting condition of the PM simulation in the simulation of future conditions. For the simulation of the existing conditions for calibration, since the models reflect the observed condition, there is a high level of continuity between the AM and PM simulations.

The input data for FREQ consist of:

- Characteristics of each ramp and mainline segment including: length, number of lanes, grade, capacity, and free-flow speed
- Traffic volume and truck percentages for each mainline segment
- Characteristics of each parallel arterial segment including: capacity, grade, free-flow speed, and signal progression, and
- Average vehicle occupancy, occupancy distribution (single person, two persons, three or more persons, and bus), and percent of trucks with a diesel engine.

The physical characteristics of the ramp and expressway sections were taken from the base FREQ input file developed by CATS staff (Schermann, 2005). The configurations of the I-290/I-294/I-88 interchange and the Dundee Road interchange were modified to reflect the improvements made at those locations. The free-flow speed and the capacity for all the arterials and also the mainline sections between Austin Avenue and Independence Boulevard were obtained from the CMAP's travel demand model. The free-flow speed and capacity for the parallel arterials are included in the Appendix.

For all the sections, with the exception of between Austin Avenue and Independence Boulevard, traffic volumes and truck percentages derived by Schermann (2005) were used. The ramp volumes for the sections between Austin Avenue and Independence Boulevard interchanges were derived from the average weekday traffic volumes recorded during the week of March 1 and 8, 2004. Although the volumes for other sections were derived based on the traffic counts from March 2002, the same data were not available

for the sections between Austin Avenue and Independence Boulevard interchanges until 2004.

There are two “splits” of traffic volumes that had be estimated from the field data. They are: the share of the traffic that splits between I-290 and the Frontage Road at Section 52, and the split between I-290 and Frontage Road for the traffic entering from I-88/I-294 (to determine the volume entering from I-88 at Section 53). The splits were estimated based on the traffic counts from 2004. The splits were then applied to the original FREQ input to derive the revised FREQ input time slice counts for Frontage Road off/on (Sections 53 and 58) for the inbound simulations.

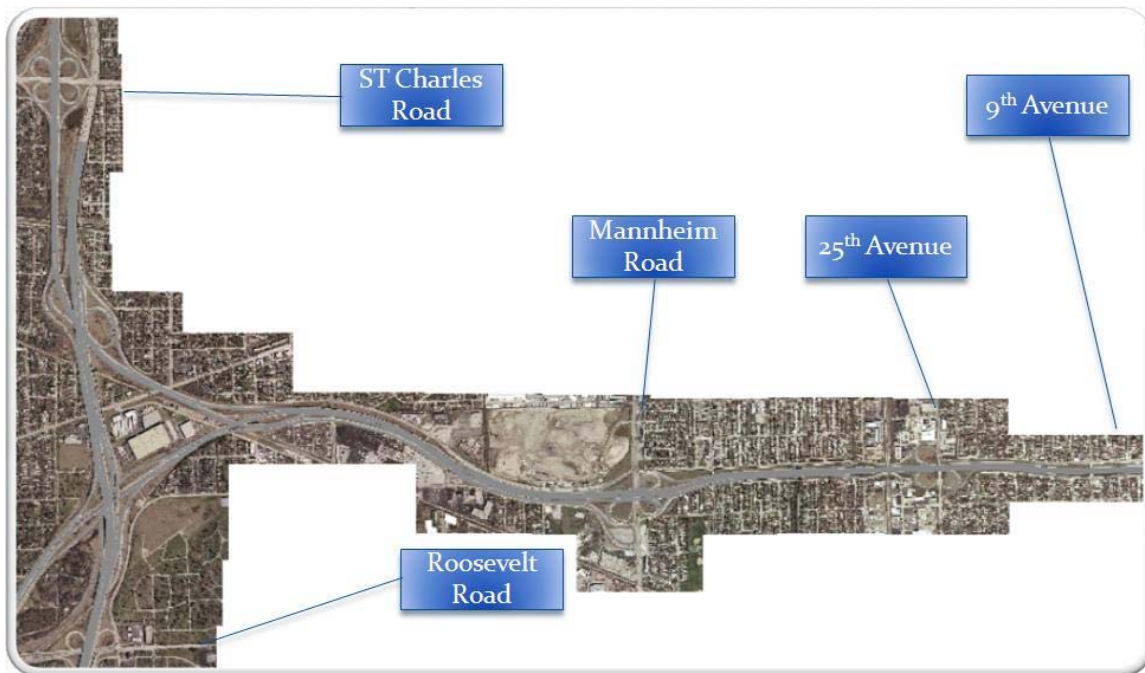
It should be noted that for the base year simulation, the capacity and free-flow speed for the parallel routes reflect the 2007 condition while the figures were revised for the 2030 simulations to include major capital projects planned or programmed for any of the arterials listed in Table 1.

For both the mainline and the arterials, vehicle occupancy distribution was assumed to be 90% SOV, 7% 2 persons per vehicle, and 3% 3+ persons per vehicle. It was also assumed that the average occupancy for the 3+ vehicles was 3.2 persons.

VISSIM simulation

We used VISSIM, one of the most popular micro-simulation programs to construct the precise model of the I-290/I-88/I-294 interchange. Figure 11 shows the modeled area. In the outbound direction, weaving sections between 17th and 25th Ave, 25th Ave and Mannheim Rd, and Mannheim Rd and Frontage Rd were modeled and similarly, in the inbound direction, weaving sections between Mannheim south on-ramp and Mannheim north off-ramp, and Mannheim Rd and 25th Ave were coded.

Figure 10 VISSIM Simulation Area



The discussion of the assumptions, data, and calibration approach used for the development of the VISSIM model are included in Appendix 1. In this section, only an overview is provided.

Since the objective of the exercise was to obtain the estimate of the capacity, the base time period for the VISSIM simulation did not have to be the same as that for the FREQ model as long as the physical configuration of the section does not differ. The traffic volumes for the I-290 sections were obtained from the IDOT detector data for May 4, 2004, the earliest date (thus the closest to the FREQ base time period) for which the data required for the VISSIM simulation were available. However, for the I-88 and I-294 segments, due to the lack of data, the Average Annual Daily Traffic (AADT) for the year 2004, published by the Illinois Toll Highway Authority, were converted to hourly volumes using the information from the Highway Capacity Manual 2000 (Transportation Research Board, 2000).

For the calibration, the data for May 2007 were used due to the lack of data for earlier time periods. An inherent assumption behind this approach is that the traffic pattern at the I-290/I-88/I-294 interchange did not change significantly between May 2004 and May 2007. **Error! Reference source not found.** Figure 11 shows an example of the calibration process. The graph compares the simulated speed profile against the actual. Other parameters such as queue length at selected locations were also used to calibrate the model.

Figure 11 AM Peak Speed Profile for Outbound Eisenhower Expressway @ 9th Ave.

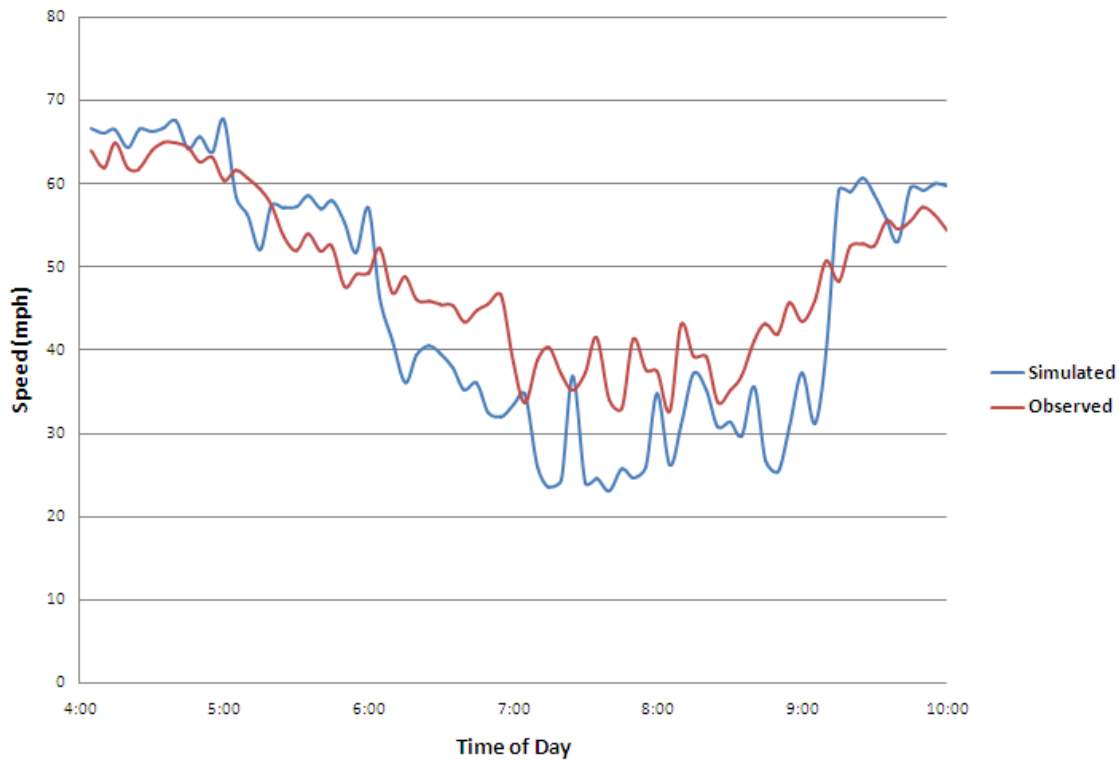


Table 2 shows the estimated capacities for the weaving sections within or near the I-290/I-88/I-294 interchange. These values were used as the starting point for the calibration of the FREQ model.

Table 2. Weaving Section Capacities Estimated Using VISSIM

Weaving Section	Lane Capacity (pcphpl)	Section Capacity (pcph)
Outbound I-290, 17th and 25th Ave	1685	8425
Outbound I-290, 25th Ave and Mannheim Rd	1575	6300
Outbound I-290, Mannheim Rd and Frontage Rd	1315	5260
Inbound Frontage road, Mannheim south on-ramp and Mannheim north off-ramp	970	2910
Inbound I-290, Mannheim Rd and 25th Ave	1305	5220

Calibration

The calibration of a FREQ model involves observing the similarities and differences between simulated and observed conditions and making adjustments to the model parameters. The speed profile of each segment and the location and duration of the queues are two most important indicators of model's performance. It is imperative that the model closely replicates the observed conditions in terms of those two indicators.

Observed conditions were derived from the IDOT detector report during the November and December of 2003. The speed data from Tuesdays and Thursdays were screened first for the signs of incidents. Then, the average speed was calculated for each time period for each segment. Speed data can also be used to identify the location and duration of the queues. The final speed profiles for both inbound (East bound) and outbound (West bound) are included in Appendix 2. While it would have been desirable to use the speed profiles from March 2002, the time period for which the traffic volume data were derived, complete detector reports were not available since some of the detectors along the study segment were not functional until November of 2003.

There are two general types of parameters to be adjusted during the calibration process. The first type is the global settings such as occupancy distributions and the shape of the speed-volume curve. Although FREQ allows these parameters to be adjusted for each section, the absence of field data precludes such local adjustments in most cases. The second type is section-specific characteristics that include: capacity, free-flow speed, and the method of capacity estimation (for merging and weaving sections).

In general, once the integrity of the input data (e.g. traffic volume) is verified, the segment-by-segment adjustment of capacity is the most important process in the calibration of a FREQ model, and this study was no exception. Below, the key assumptions and adjustments made during the calibration are summarized.

Outbound (AM and PM)

- The capacity for each segment must be the same for AM and PM simulations.
- The calibration process started with the PM simulation since congestion is greater, and thus more bottleneck conditions could be observed.
- For segments without any plausible reason for capacity reduction, such as substandard configuration, 2100 vehicles per hour per lane (vphpl) was used
- The key bottlenecks for the outbound direction are: the lane drop at the Austin Avenue exit (Section 9), the segments between the Harlem Avenue entrance (Section 12) and the 25th Avenue interchange (Section 20), and the segments between the York Road entrance (Section 38) and the I-355 exit (Section 44).
- While the lane reduction at the Austin exit (Section 9) presents a significant decrease in the capacity, another bottleneck exists between the Harlem Avenue entrance and the Des Plaines entrance (Section 12). The estimated capacity for Section 12 is 5850 vehicles per hour (vph), which is equivalent of approximately 1615 vphpl, an unusually low figure for a regular expressway segment. There are several plausible explanations for this. Firstly, the left-side entrance (at Harlem Avenue) followed by the right-side entrance (at Des Plaines Avenue) leaves only the center lane without disturbance in the traffic flow.

Secondly, the merging at the Harlem entrance is made difficult by the fact that due to the difference in the elevations, neither the mainline vehicles nor entering vehicles can visually recognize each other until the last moment. And finally, overpasses may present visual distraction for the drivers, especially during the merging. For other sections, between 13 and 20, congestion is caused simply by the gradual buildup of mainline volumes due to the constant stream of entering vehicles at the interchanges at Des Plaines Avenue, 1st Avenue, 17th Avenue and 25th Avenue.

- For the segments between York Road entrance (Section 38) and I-355 exit (Section 44), a prolonged congestion, both temporary and spatially, is not caused by a single segment. Rather, a series of weaving and merging, occurring in a relatively short distance, creates a complex pattern of disturbance. As a result, those sections operate at or near capacity for a long period of time, a condition that easily leads to congestion.

Figure 12 and **Error! Reference source not found.**3 show the simulated conditions for the outbound AM and PM periods, respectively. The blue areas represent near capacity conditions where the volume-to-capacity ratio (V/C) is between 0.9 and 1.0. Yellow segments are bottlenecks ($V/C = 1.00$). In most cases, red areas that represent congested conditions immediately following the bottleneck, the yellow section. Table 3 and Table 4 provide reference for the correspondence between the section numbers and the I-290 segments. These graphical outputs and also the speed profiles, included in the Appendix, were used to guide the calibration process. Through the adjustments of capacities for the key segments, a close approximation of the observed conditions was attained.

Table 3. Section numbers lookup table – Inbound

Section	Location
1	WB Lake-Cook Start
2	EB Lake Cook On/Dundee Off
3	Dundee Off/WB Dundee On
4	WB Dundee Rd. On
5	EB Dandee On/Rand On
6	Rand On/WB Palatine Off
7	WB Palatine Off/On
8	WB Pala On/EB Pala Off
9	EB Palatine Off/On
10	EB Pala On/NW Hwy Off
11	NW Hwy Off/On
12	NW Hwy On/WB Euclid Off
13	WB Euclid Off/On
14	WB Euclid On/EB Euc. Off
15	EB Euclid Off/On
16	EB Euclid On
17	Kirchoff On
18	Algonquin Off
19	Algonquin Off/On
20	Algonquin on/WB I-90 off
21	WB I-90 Off/On
22	WB I-90 on/EB I-90 off
23	EB I-90 Off/On
24	EB I-90 on/Woodfield off
25	Woodfield Off/Higgins Off - 6 Ln
26	Woodfield Off/Higgins Off - 5 Ln
27	Higgins Rd. off
28	Higgins Off/On
29	Higgins On/Biesterf. off
30	Beisterfield Off/On
31	Biesterf. on/Thornd. off
32	Thorndale Off/WB On
33	WB Thorndale on
34	EB Thorndale on/I-355 off
35	I-355 Off/NB On
36	NB I-355 on
37	SB IL 83 off
38	SB IL83 Off/On
39	SB IL 83 on/NB IL 83 off
40	NB IL83 Off/On

Section	Location
41	NB IL 83 on
42	York St. on & off
43	EB North Ave. off
44	EB North Off/WB On
45	WB North on
46	EB North on/WB STC off
47	WB STC Off/On
48	WB STC on/EB STC off
49	EB STC Off/On
50	EB STC on/SB I-294 off
51	SB I-294 Off/On
52	SB I-294 on/FR Rd. off
53	Fr.Rd off/I-88 Merge
54	I-88 Merge
55	I-88 Merge/Fr. Rd On
56	I-88 Merge/Fr. Rd On
57	I-88 Merge/Fr. Rd On
58	Fr Rd. On
59	Fr.Rd. On/SB 25th off
60	SB 25th Off/SB 25th On
61	SB 25th Off/SB 25th On
62	SB 25th on/NB 25th off
63	NB 25th Off/On
64	NB 25th on/17th Ave. off
65	17th Ave. Off/On
66	17th Ave. on
67	9th on/1st off
68	1st Off/On
69	1st on/Des Plaines off
70	Harlem Ave. off
71	Harlem Off/On
72	Harlem on/Austin off
73	Austin Off/On
74	Austin On/Central Off
75	Central Off/On
76	Central On
77	Laramie On/Cicero Off
78	Cicero Off/On
79	Kostner On/Indep. Off
80	Indep. Off/On
81	Indep. On

Table 4. Section numbers lookup table – outbound

Section	Location
1	Indep. Off
2	Indep. Off/On
3	Indep On/Kostner Off
4	Kostner Off/Cicero On
5	Cicero On/Laramie Off
6	Laramie/Central Off
7	Central Off/On
8	Central On/Austin Off
9	Austin Off/On
10	Austin on/Harlem off
11	Harlem Off/On
12	Harlem Ave. on
13	Des Plaines on/1st off
14	1st Ave. Off/On
15	1st on/9th off
16	17th Ave. off
17	17th Ave. Off/On
18	17th Ave on/NB 25th off
19	SB 25th Ave. off
20	SB 25th Ave. Off/On
21	25th on/Mann. off
22	Mannheim Off/NB On
23	NB Mann on
24	SB Mann On/Hillside Off
25	I-88 Split
26	NB I-294 off
27	NB I-294 Off/On
28	NB I-294 on/EB STC off
29	EB STC Off/On
30	EB STC on/WB STC off
31	WB STC Off/On
32	WB STC on/EB Lake off
33	EB Lake Off/SB I-294 On
34	SB I-294 on/WB North off
35	WB North Off/On
36	Lake-North on/WB Lake off
37	WB Lake Off/York On
38	York on/NB IL 83 off
39	NB IL83 Off/On
40	NB IL 83 on/SB IL 83 off

Section	Location
41	SB IL83 Off/On
42	SB IL 83 on
43	SB I-355 off
44	I-355 on.off
45	I-355 merge/Thornd. off
46	Thorndale Off/EB On
47	EB Thorndale Ave. on
48	WB Thorn. on/Biest. off
49	Biesterfield Off/On
50	Biest. on
51	Diverge
52	Higgins Off
53	Higgins Off/On
54	Higgins on
55	Diverge
56	Woodfield on/I-90 off
57	I-90 Off/EB On
58	EB I-90 on/WB I-90 off
59	WB I-90 Off/On
60	WB I-90 on/Algonquin off
61	Algonquin Off/Merge
62	Merge
63	Algonquin on
64	lane merge/Kirchoff off
65	EB Euclid Ave. off
66	EB Euclid Off/On
67	EB Euclid on/WB Euc. off
68	WB Euclid Off/On
69	WB Euclid on/NW Hwy off
70	NW Hwy Off/On
71	NW Hwy on/EB Pala. off
72	EB Palatine Off/On
73	EB Pala. on/WB Pala. off
74	WB Palatine Off/On
75	WB Palatine on/Rand off
76	IL Rt. 68/Dundee Rd. off
77	Dundee Rd. Off/On
78	Dundee on/EB LC off
79	WB Lake Cook Off
80	Final Merge

Figure 10 2002 Base Condition – Outbound AM Simulation

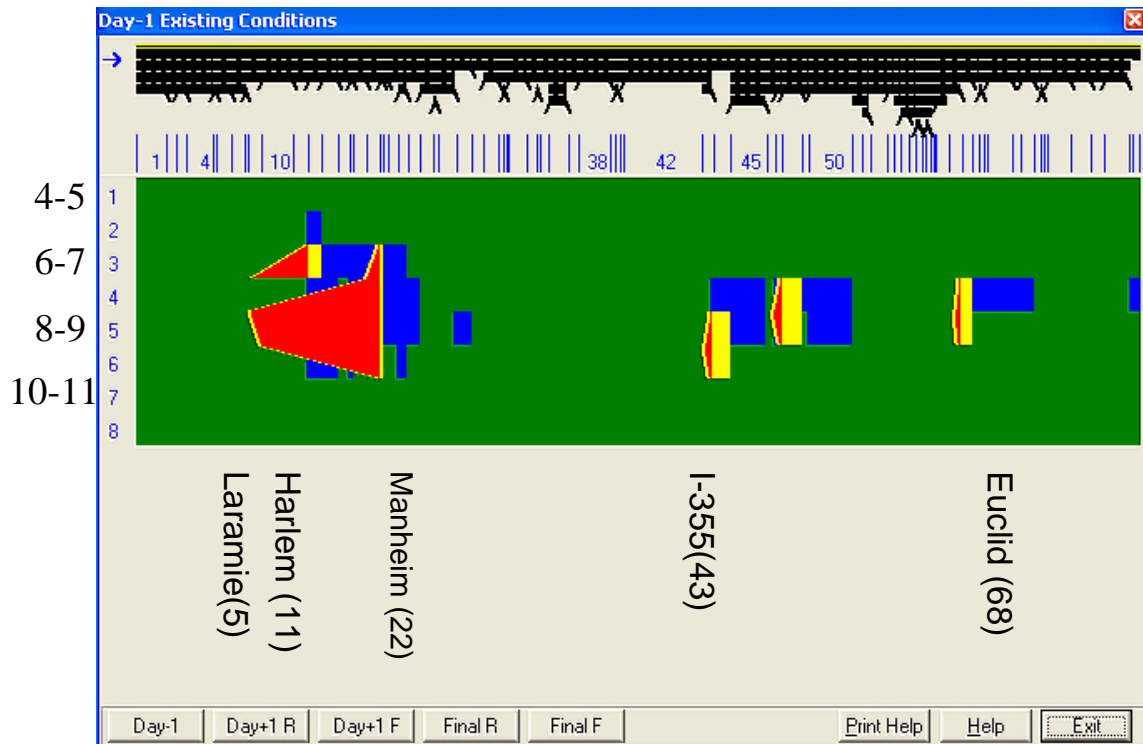
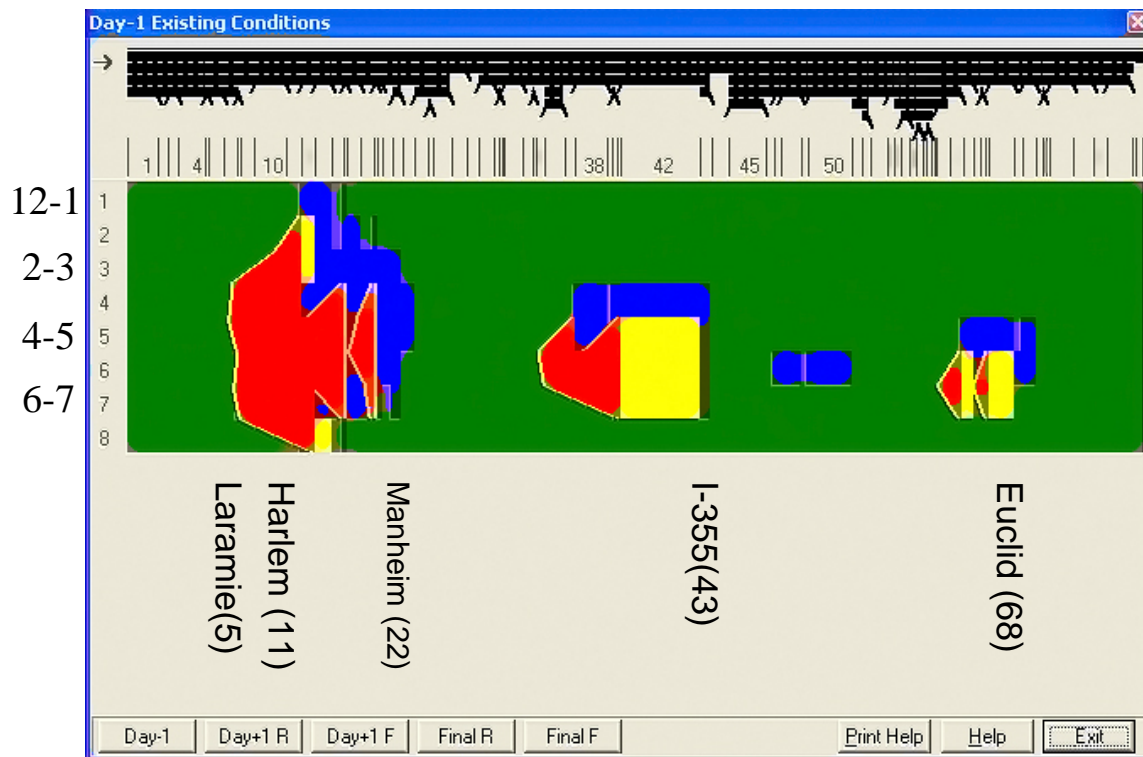


Figure 11 2002 Base Condition – Outbound PM Simulation



Inbound (AM and PM)

- The capacity for each segment must be the same for AM and PM simulations.
- The calibration process started with the PM simulation since congestion is greater, and thus more bottleneck conditions could be observed.
- For segments without any plausible reason for capacity reduction, such as substandard configuration, 2100 vehicles per hour per lane (vphpl) was used.
- For the inbound simulations, the default lower limb speed (the part of the speed-flow curve that represents over-saturated condition) was changed from 30 mph to 35 mph for the entire study area since the speed within the queue seem to be more accurate with the latter especially for the Sections 5 (Dundee Road entrance) to 17 (Kirchoff Road entrance) for the PM simulation.
- The key bottlenecks for the inbound direction are: Euclid Avenue entrance (Section 16), Southbound I-294 connector (Section 50), multiple segments between the Frontage Road merge (Section 59) to Austin Avenue entrance (Section 73). In addition, a light speed drop is observed for the fly-over bridge at the I-290/I-355 Interchange (Section 35)
- The two-lane section of I-290 at the I-355 interchange (Section 35) is a fly-over bridge with a tight horizontal curve and a limited line of sight. Thus, the capacity and speed were decreased to 3300 vph and 50 mph, and also the highest upgrade (4%) allowed by FREQ was used.
- The effect of the queue spillover from the southbound I-294 connector was simulated by reducing the capacity of the mainline to 4000 vph⁴. This figure is extremely low for a 3-lane expressway section. During the peak periods, Section 50 operates essentially as a two-lane segment since the outermost lane is occupied by the queued vehicles that are exiting to I-294.
- The congestion that is observed between the I-290/I-294/I-88 interchange and Austin Avenue interchange (Sections 59 through 73) seems to be caused by the combined effect of a series of segments that are operating at or near capacity for a prolonged period of time each day. Calibrated capacities for these segments are well below 2000 vphpl, indicating a presence of factors that causes driver distraction, as discussed earlier for the outbound simulation. In addition to the overpasses and left-side entrance/exit that were mentioned as the possible factors in the previous section, the left-shoulder clearance is substandard for a short distance between the 1st Avenue and Des Plaines Avenue interchanges. Furthermore, the results indicate that the weaving sections are operating well below the expected capacity. For example, even with the auxiliary lane, the estimated capacity at the 25th Avenue interchange is only 5800 vph for a four-lane section.
- VISSIM-estimated capacity was used for the section 59 (Frontage Road entrance to Southbound 25th Avenue exit)⁵.

⁴ It should be noted that congestion already exists at 12 noon, thus it is impossible to replicate the measured speed in the PM simulation. Thus, for section 50, AM run is used to estimate the capacity.

⁵ Research have shown that weaving section capacity can be significantly lower than the HCM method suggest, and the result of the VISSIM simulation confirmed it.

- The capacity for the last segment, Section 81, was reduced to replicate the congestion that originates around Western Avenue, which is outside of the study area.

Figure 12 2002 Base Condition – Inbound AM Simulation

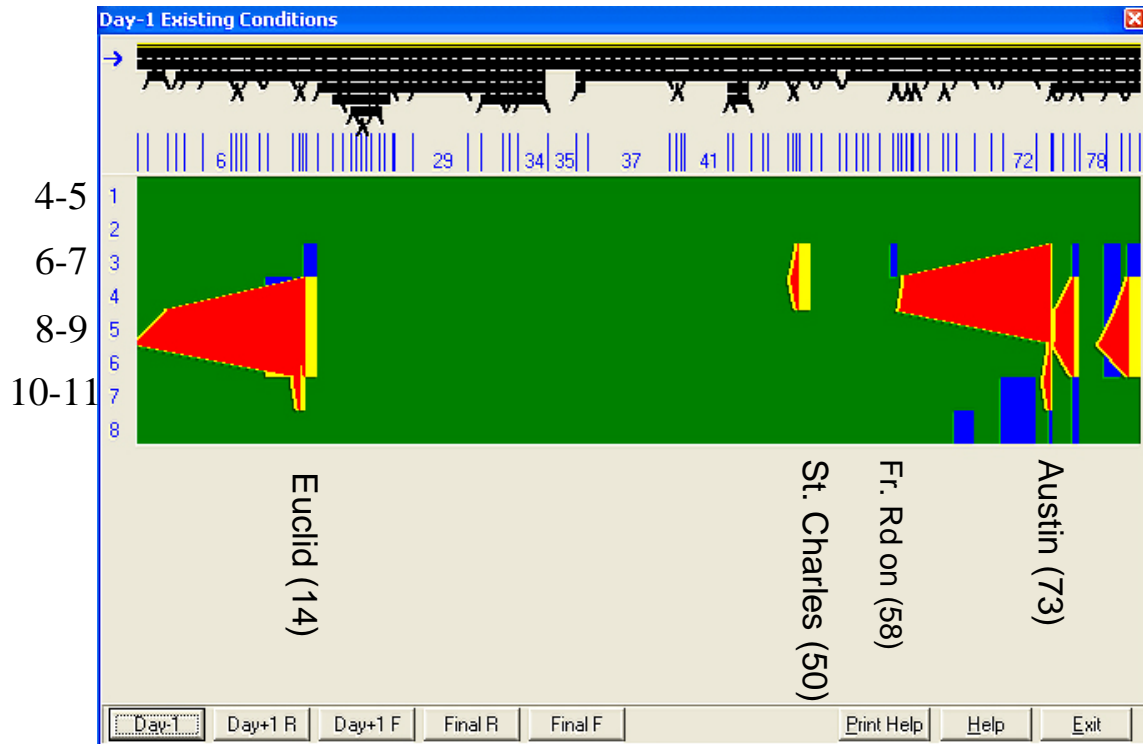
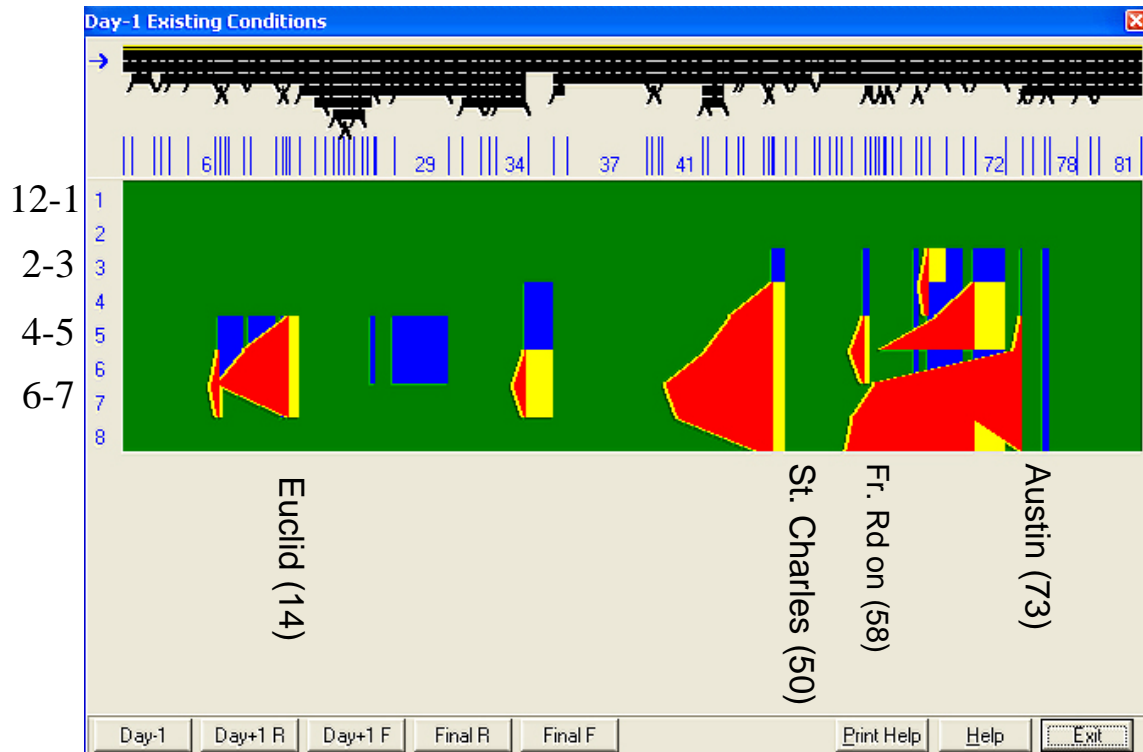


Figure 13 2002 Base Condition – Inbound PM Simulation



IV. Alternate Scenarios

Using the FREQ models that were calibrated for the 2002 conditions, following alternatives for 2030 were analyzed.

- 2030 without ramp metering (base condition)
- 2030 with ramp metering
- 2030 with ramp metering with spatial shift
- 2030 with ramp metering with HOV priority entry lane (PE)
- 2030 with ramp metering with HOV priority entry lane (PE) and spatial shift
- 2030 with ramp metering with HOV priority entry lane (PE) and spatial and modal shifts
- 2030 with ramp metering with HOV priority entry lane (PE) with Bus Service
- 2030 with ramp metering with HOV priority entry lane (PE) and spatial shift with Bus Service
- 2030 with ramp metering with HOV priority entry lane (PE) and spatial and modal shifts with Bus Service

This section discusses the approach used for the simulation and analysis of these scenarios.

Growth rates

The growth rates for individual ramps were developed based on the 24-hour volumes from the CMAP 2030 demand forecasting model. Since some sections of parallel arterial are already over the specified capacity for the 2002 base case, FREQ does not allow growth factors to be applied to the arterial volume if the demand for the arterial is already at the capacity. However, some of the growth rates projected by the CMAP model were extremely large or small. Thus, the minimum and maximum growth rates of 0.8 and 2.0, respectively, were used to limit the growth rate inputs to FREQ to levels consistent with CMAP 2030 model or VISSIM-determined capacity.

Spatial shift

As mentioned earlier, FREQ simulate two types of route diversion behavior. The first type is termed “short trip response” that represents the route diversion for the travelers whose trip destination is within the study area. FREQ assumes that for those short trips, the travelers who divert to surface streets due to the on-ramp delay complete the trip on the surface streets. On the other hand, “long trip response” assumes that the destination of the trip is outside (i.e. downstream of) the study area. For the long trips, it is assumed that the travelers who diverts due to on-ramp delay will divert to the next on-ramp downstream only if such a diversion would results in a travel time saving. Unfortunately, this simple diversion mechanism tends to create unreasonably long queues at the ramps that are immediately downstream of the freeway bottleneck segments. For this reason, long trip response was excluded from the simulation for this study.

Modal shift

FREQ can be used to simulate the modal shift among SOV, HOV, and buses. FREQ does not simulate the mode shift involving rail transit. FREQ uses logit model to estimate the mode shift with in response to the changes in the relative attractiveness of each mode. Although users can define the parameters of the logit model, the default value was used for this study due to the absence of information. Although CMAP’s demand forecasting model also uses logit model, parameters are not transferable since the choice sets are different. In particular, the zonal socioeconomic factors that may affect mode choice within the CMAP model are not transferable.

FREQ allows short-trip diversion, long-trip diversion, and modal shift to be simulated in all possible combinations of order. From behavioral perspective, as is done in the travel demand forecasting, it is natural to assume that the possibility of spatial diversion is considered first by the travelers because mode shift often require greater adjustments to travel habits. Thus, the sequence of simulation was to the short-trip spatial shift followed by the modal shift.

Optimization of ramp metering rates

FREQ allows users to choose four different objectives when optimizing the metering rates. They are: “maximize vehicle input to freeway”, “maximize vehicle-miles of freeway travel”, “maximize passenger input to freeway”, and “maximize passenger-miles of freeway travel”. However, when performing a simulation without HOV priority entry (PE) lanes, only the first two types of objectives are available. This creates a problem

since in order to minimize the passenger travel time-the third objective, maximize passenger input to freeway” is the most effective approach. Choosing the first two objectives tend to increase the passenger travel time. Therefore, the results from the simulations with and without PE lanes are not directly comparable. In fact, they tend to produce vastly different results. Furthermore, mode shift can be engaged only when HOV priority entry lanes are simulated.

For each scenario, metering rate and queue limit at each on-ramp were adjusted to find the optimum combination that minimized the passenger travel time. Since the adjustments relied on try-and-error process, the results are not likely to be the true mathematical optimum. However, the results presented here should be sufficiently close to the true optimum for the purpose of the study.

Simulation Parameters

Following are parameters used for the simulations of 2030 conditions.

- Cutoff level for priority entry = 2 passengers per car
- Optimization criteria for the ramp metering rates = “maximize passenger input to freeway” for the PE scenarios, “maximize vehicle input to freeway” for others
- In most cases, not engaging the ramp queue length limits produces significant saving in the total passenger travel time. However, it is unrealistic to assume that a large number of vehicles, sometimes exceeding 1000 vehicles, can be stored at a ramp. Even if it were physically possible, such a long queue would prompt a large portion of the drivers to violate the ramp meters or would be politically unviable as an invitation to use arterials and collector streets for regional travel. Therefore, queue length limits varying between approximately 80 and 200 vehicles were applied to the ramps. While detailed analysis was not conducted, the limits at individual ramps generally reflect the surrounding land use and the layout of the surface streets.
- Ramp metering was not applied to expressway-to-expressway connections and the Frontage Road on-ramp.
- Minimum time savings for spatial response to occur = 5 minutes

V. Findings

This section summarizes the key findings from the FREQ analysis of the 2030 alternates. Detailed outputs from the FREQ simulations are included in the Appendix.

Ramp metering without HOV priority entrance (PE)

Error! Reference source not found.5 summarizes the results of the simulations with ramp metering without PE. As shown, without the PE, the benefit of ramp metering is modest. Although the congestion on the mainline can be reduced significantly with ramp metering as depicted in the example for the inbound AM simulation (16 through Figure 18), a massive increase in the delay at the ramps offsets the benefit.

Table 5. Simulation Results - 2030 Ramp Metering without Priority Entrance

Scenario		1	2	3	% change	
Mainline, Ramp & arterial	2002 base	2030 base	2030 ramp meter only	2030 ramp meter and spatial shift	3-1	2-1
Passenger hours	305,181	411,692	421,618	403,560	-2.0%	2.4%
Total Vehicle miles traveled	7,822,471	7,932,117	7,944,586	7,952,905	0.3%	0.2%
Total Gas consumption (gallons)	2,005,356	1,751,407	1,749,918	1,761,107	0.6%	-0.1%
Total VOC (tons)	2,303	3,239	3,296	3,162	-2.4%	1.8%

When the queue at a ramp reaches the pre-specified limit, the FREQ program increases the metering rate (i.e. flow is increased) to prevent the queue to extend beyond the limit. This situation, which is relatively common, limits the effectiveness of ramp metering. As a result, ramp metering was not able to reduce the congestion at some of the major bottlenecks including: Euclid Avenue entrance at Section 16 for the inbound, and the entrances at Austin Avenue (Section 9) and Harlem Avenue (Section 12) in the outbound direction. At these locations, there are not enough ramps in the upstream to curtail the traffic volume to the point where congestion is reduced while keeping the queue length below the limit.

When ramp meters are not able to decrease the downstream congestion, it is often detrimental to operate the meters since it generates queuing delay at the ramps without significant reduction in the mainline travel time. For those situations, some of the ramp meters must to be tuned off to reduce the ramp delay and the overall travel time. In the inbound direction, the queue length limits were set at 10 vehicles for the ramps between the beginning of the corridor at Lake-Cook Road and Kirchoff Road. For the outbound direction, the same queue limit was applied for the ramps between the beginning of the study corridor at the Independence Avenue entrance and the 1st Avenue entrance.

Figures 16 through 18 show that ramp metering was able to dissolve congestion at near Austin and St. Charles Road interchanges. However, the increase in delay at the ramps and arterials, and the persistent congestion near the Euclid interchange lead to only a modest decrease in the overall passenger travel hours (2.4%). The outbound PM simulations, depicted in Figure 19 through Figure 21 indicate similar situations. For the outbound, the location of the most serious bottleneck is near the beginning of the study section. Combined with the lack of storage space at the ramps in the Chicago and inner suburban communities, ramp metering has failed to reduce congestion in any noticeable manner. As a result, the overall reduction in PHT is merely 1.39%. The analysis comparisons depicting the 2030 Inbound PM and Outbound AM conditions under all scenarios described on page 29 can be found in Appendix 4.

Figure 14 **2030 Base Condition - Inbound AM**

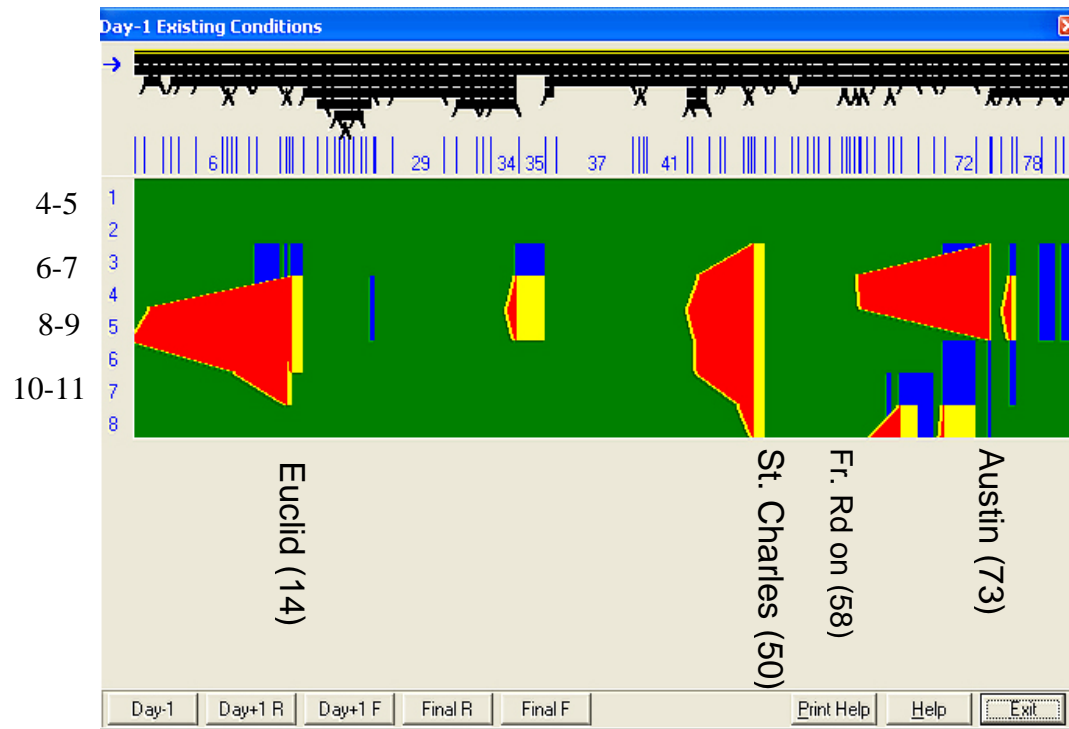


Figure 15 **2030 with Ramp Meters without Spatial Shift - Inbound AM**

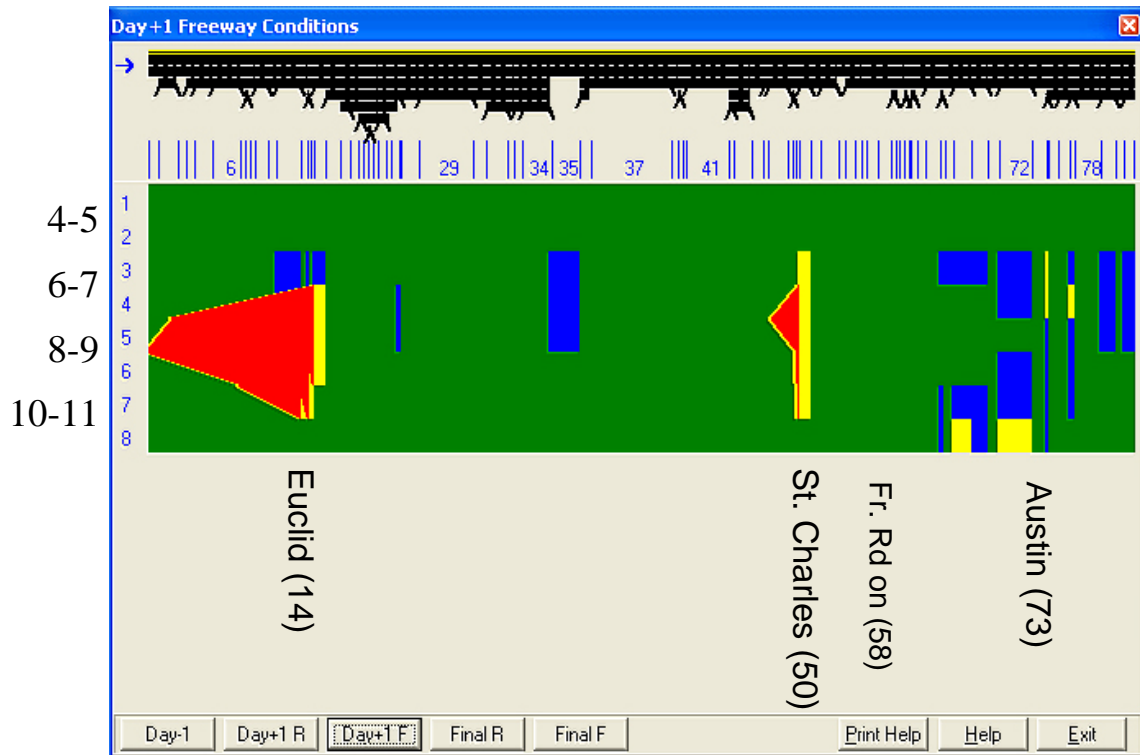


Figure 16 2030 with Ramp Meters with Spatial Shift - Inbound AM

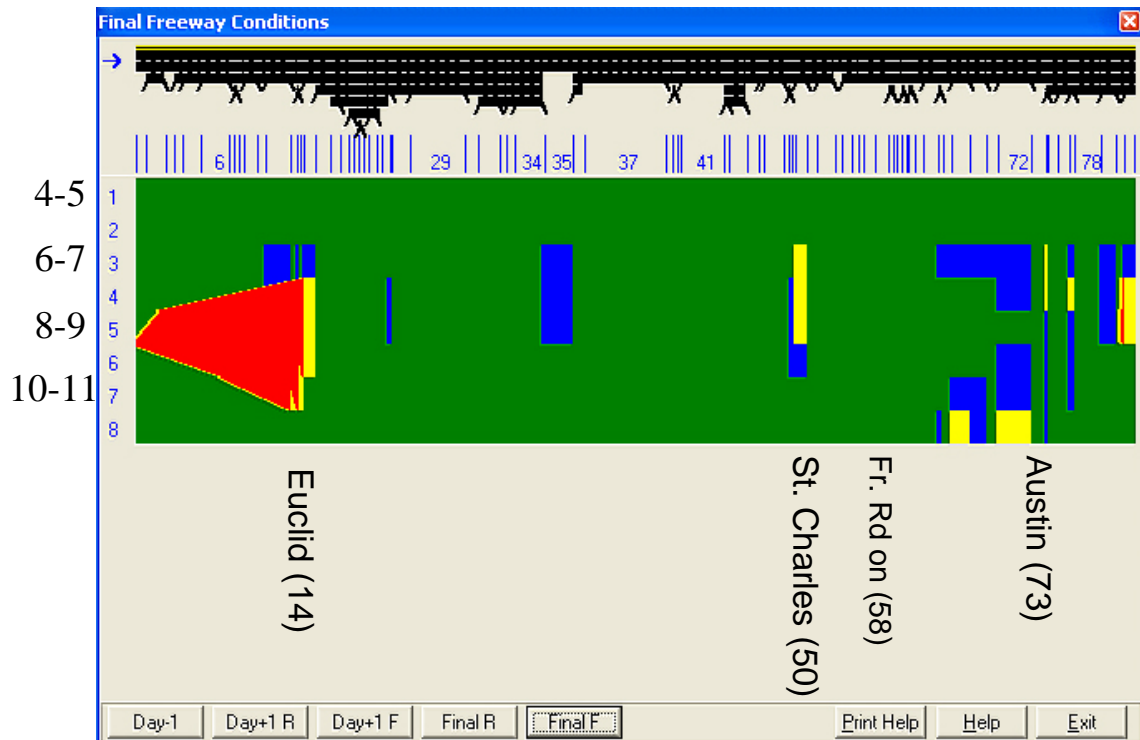


Figure 17 2030 Base Condition - Outbound PM

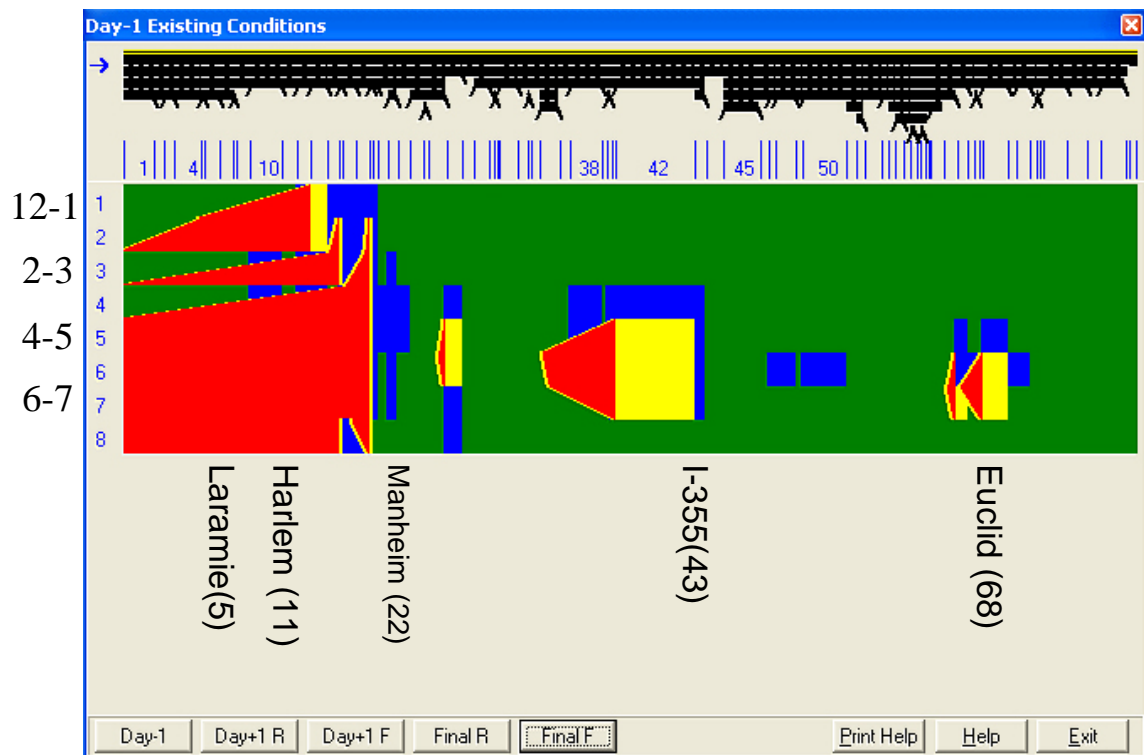


Figure 18 2030 with Ramp Meters without Spatial Shift - Outbound PM

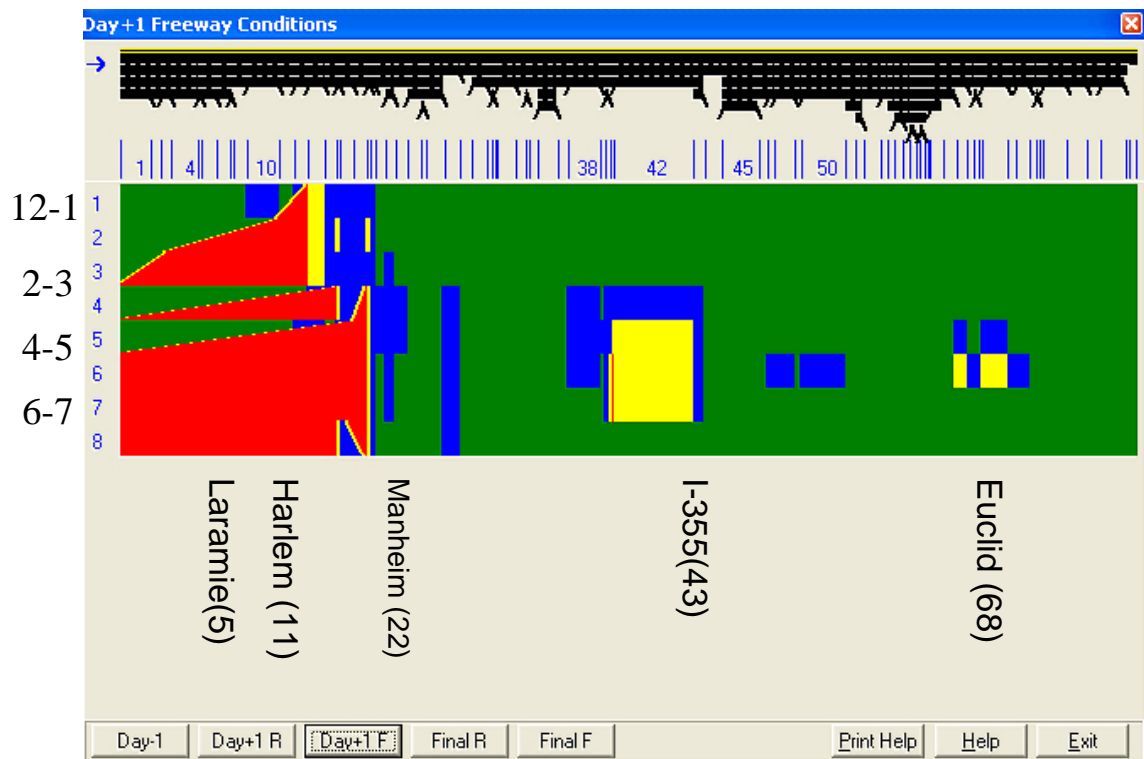
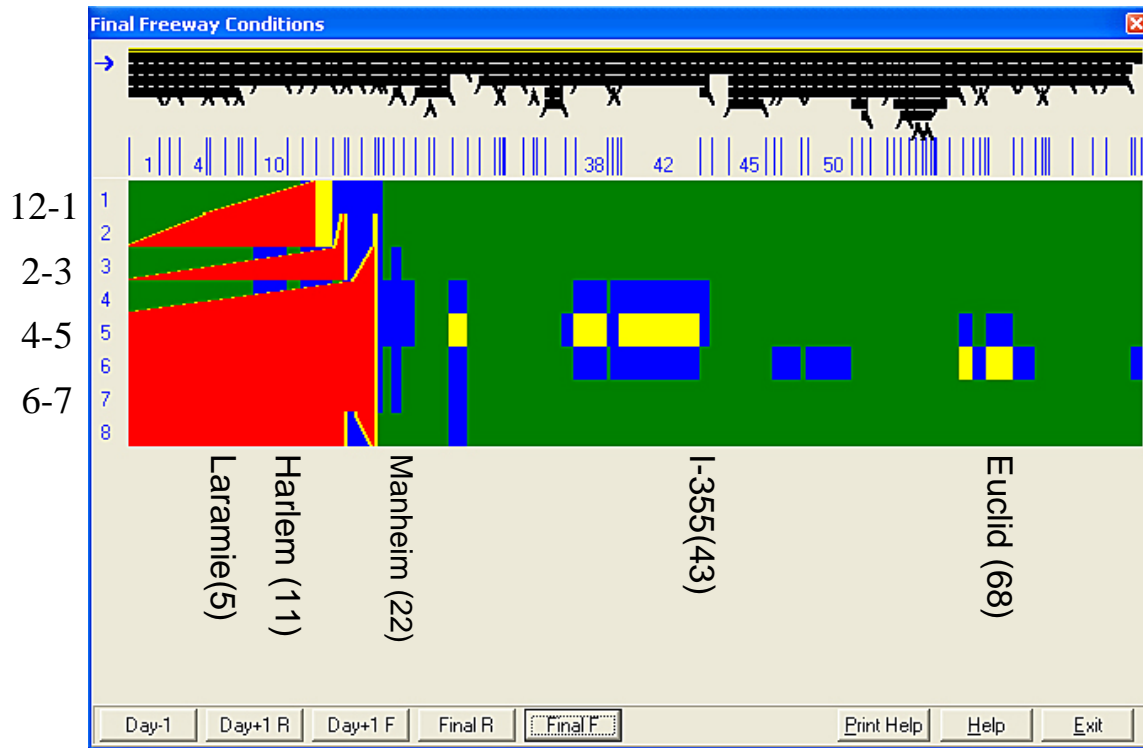


Figure 19 2030 with Ramp Meters with Spatial Shift - Outbound PM



Ramp metering with HOV priority entrance

As shown in Table 6, when HOV priority entrance lanes are combined with mode and spatial shifts, ramp metering can achieve considerable reduction in travel time. Although the scenarios without mode shift seem to worsen the traffic conditions, it is mainly due to the fact that the metering strategies were optimized to produce the greatest benefit under the Scenario 4. If the metering rates were optimized for the Scenarios 2 or 3, the results would have been similar to those reported for the ramp metering without PE. It should be noted that bus services were not considered in the analysis. Therefore, only the shift between SOV and HOV modes are simulated. When PE is engaged, it is possible to use aggressive metering strategies without violating the queue limit constraint since more travelers shift to HOV as the ramp delay increases. As shown in Figure 23, ramp metering dissolves all the congestion along the study corridor.

Table 6. Simulation Results - 2030 Ramp Metering with Priority Entrance

Scenario		1	2	3	4	% change		
Mainline & Ramp	2002 base	2030 base	2030 ramp meter only	2030 ramp meter and spatial shift	2030 ramp meter, spatial and modal shift	4-1	3-1	2-1
Passenger hours	125,955	272,059	304,818	290,070	229,164	-15.8%	6.6%	12.0%
Total Vehicle miles traveled	4,930,839	5,040,485	5,058,316	5,027,556	4,992,509	-1.0%	-0.3%	0.4%
Total Gas consumption (gallons)	292,276	354,367	367,654	360,248	332,169	-6.3%	1.7%	3.7%
Total VOC (tons)	1,478	2,508	2,726	2,612	2,132	-15.0%	4.1%	8.7%

Figure 20 2030 with Ramp Meters with PE with Spatial Shift - Inbound AM

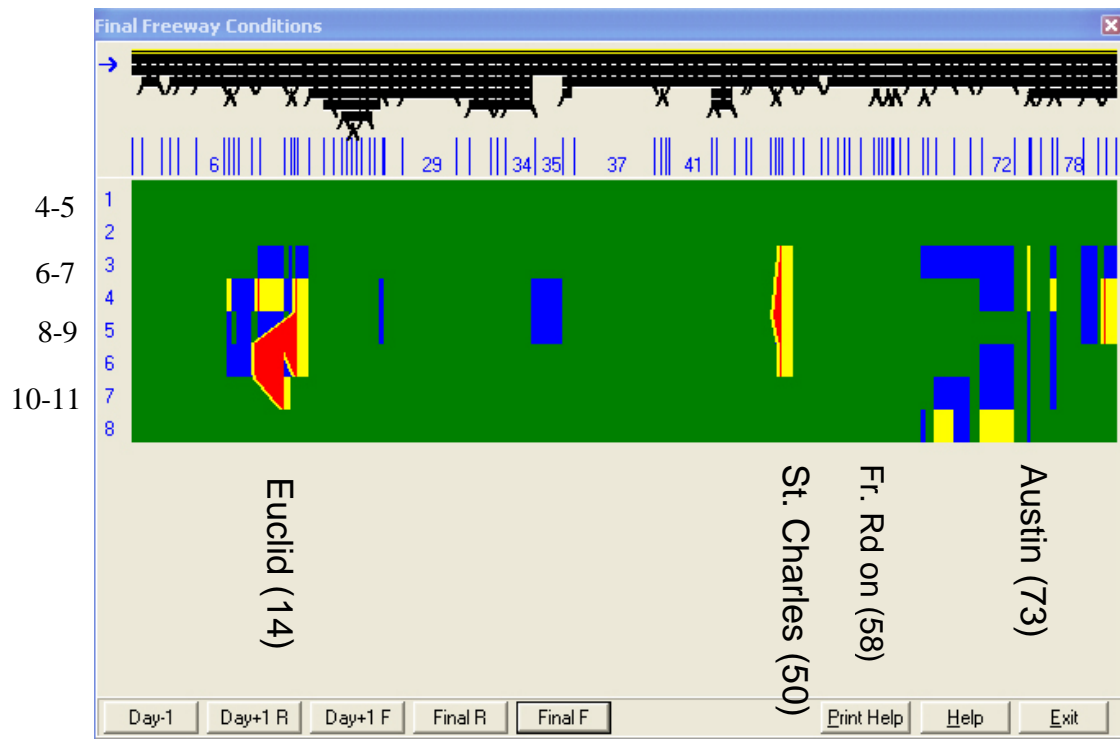


Figure 21 2030 with Ramp Meters with PE with Spatial and Mode Shift - Inbound AM

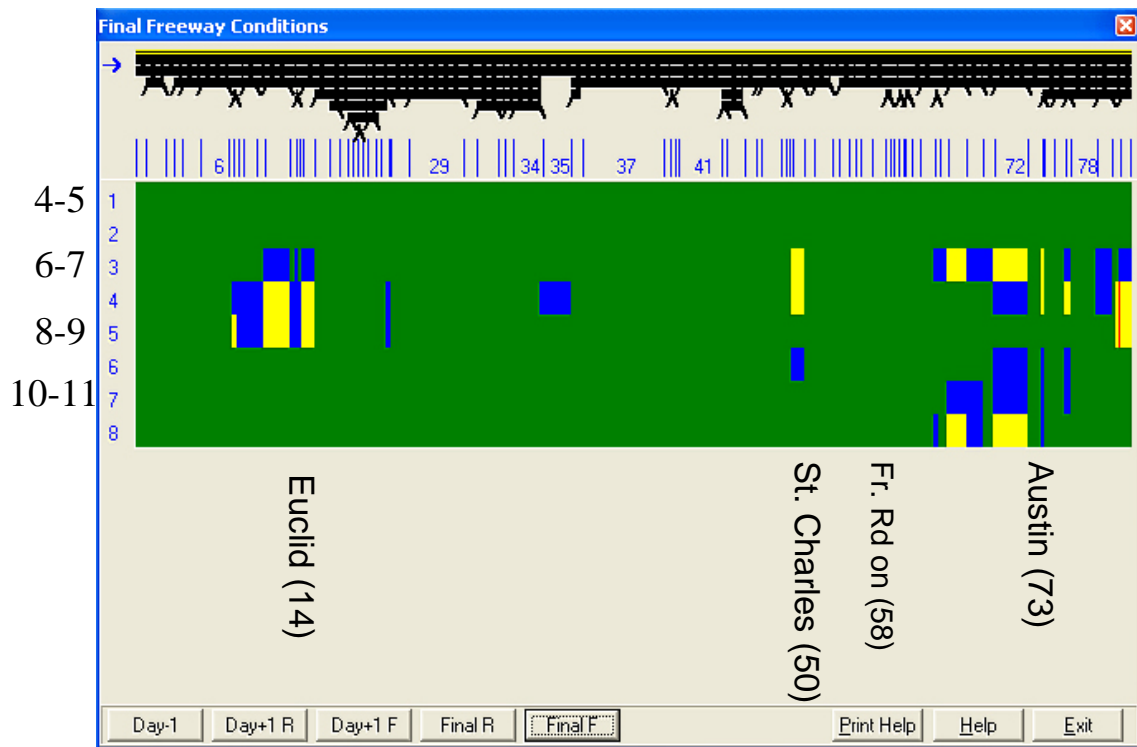


Figure 24 and Figure 25 depict the outputs for the outbound PM simulations. In contrast to the inbound simulations, ramp meters, even with PE, were not able to improve the severe congestion between the Independence Avenue (Section 1) and 25th Avenue Interchange (Section 20). This is mainly because of the lane imbalance – reduction from 4 lanes to 3- occurring west of Austin Ave and also because, as discussed earlier, there are not enough ramps in the upstream of the bottleneck at Harlem Avenue (Section 12) to be metered. Conversely, if the study area were to be expanded eastward and include more ramps, it may be possible to demonstrate additional congestion reduction more effectively.

Overall, the reductions in PHT, VMT, gallons of fuel consumed, and VOCs emitted from the managed mainline and ramp traffic flow should be compared along slight (<10%) increases in these same performance measures experienced by the arterial system. Even with the arterial system included in the comparison, the greater I-290/IL 53 corridor still enjoys significant reductions in PHT and VOCs emitted. VMT remains reduced but at a lower magnitude, whereas gallons of fuel consumed would rise by 5.3%.

Table 7. Simulation Results for Arterial and for combined Mainline, Ramp & Arterial, 2030 Ramp Metering with Priority Entrance

Scenario	1		2		3		4		% change
Arterial	2002 base	2030 base	2030 ramp meter only	2030 ramp meter and spatial shift	2030 ramp meter, spatial and modal shift	4-1	3-1	2-1	
Passenger hours	179,226	139,633	139,633	145,218	145,218	4.0%	4.0%	0.0%	
Total Vehicle miles traveled	2,891,632	2,891,632	2,891,632	2,924,669	2,924,669	1.1%	1.1%	0.0%	
Total Gas consumption (gallons)	1,713,080	1,397,040	1,397,040	1,512,238	1,512,238	8.2%	8.2%	0.0%	
Total VOC (tons)	825	731	731	748	748	2.3%	2.3%	0.0%	

Scenario	1		2		3		4		% change
Mainline, Ramp & arterial	2002 base	2030 base	2030 ramp meter only	2030 ramp meter and spatial shift	2030 ramp meter, spatial and modal shift	4-1	3-1	2-1	
Passenger hours	305,181	411,692	444,451	435,288	374,382	-9.1%	5.7%	8.0%	
Total Vehicle miles traveled	7,822,471	7,932,117	7,949,948	7,952,225	7,917,178	-0.2%	0.3%	0.2%	
Total Gas consumption (gallons)	2,005,356	1,751,407	1,764,694	1,872,486	1,844,407	5.3%	6.9%	0.8%	
Total VOC (tons)	2,303	3,239	3,457	3,360	2,880	-11.1%	3.7%	6.7%	

Figure 22 2030 with Ramp Meters with PE with Spatial Shift - Outbound PM

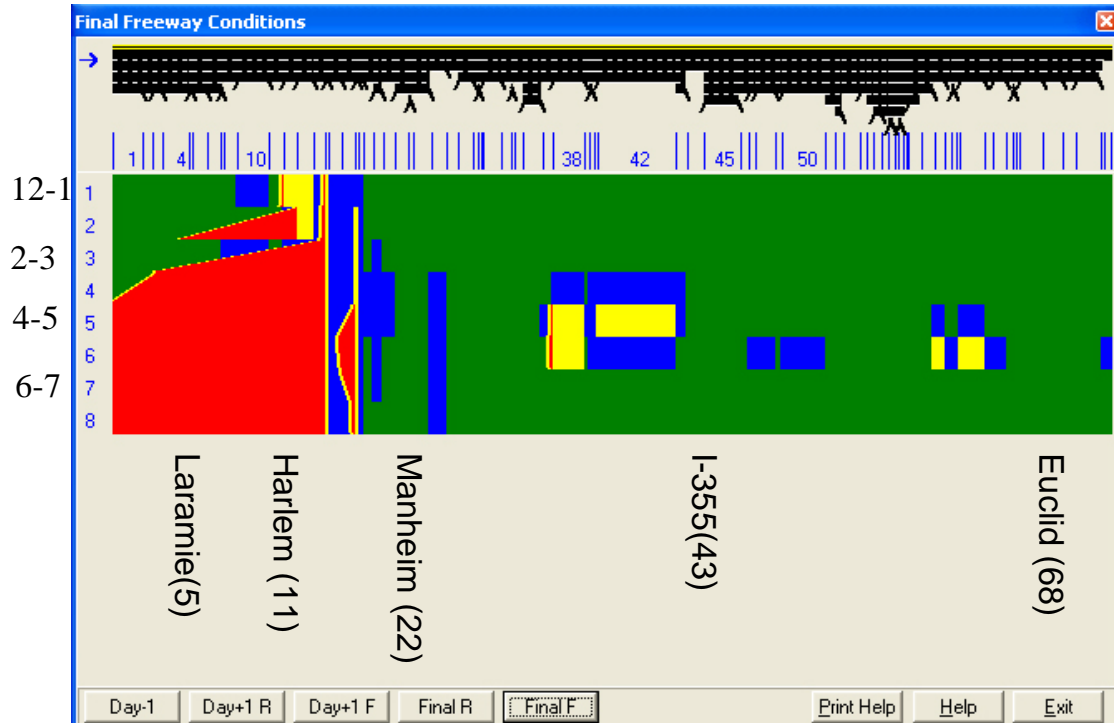
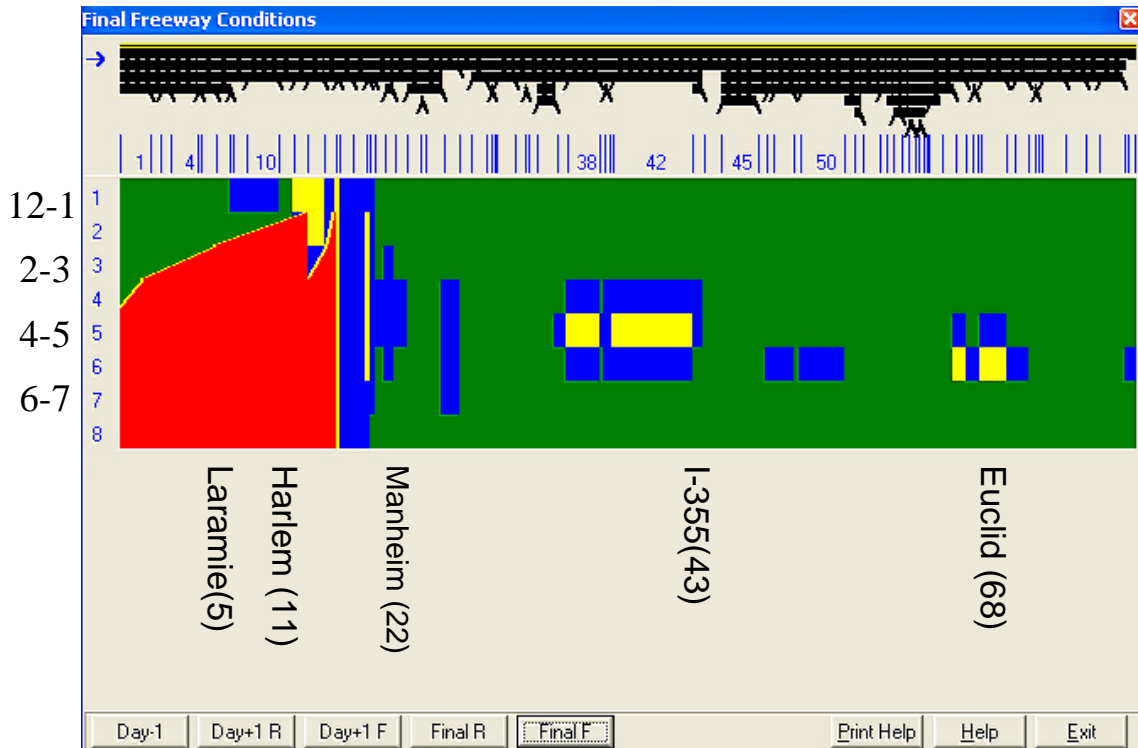


Figure 23 2030 with Ramp Meters with PE with Spatial and Mode Shift - Outbound PM



Ramp metering with HOV priority entrance with bus service

FREQ is capable of simulating the effect of bus services that provide alternative means to travel on the expressway. It should be noted that FREQ only simulates the effect of bus services that travel on the expressways (with a priority entry when it is engaged). Thus, analysis does not reflect the effect of local buses that use arterials in the modal shift.

Bus service was simulated for the 2030 conditions. To engage bus transit, the default occupancy (i.e. mode share) was set to bus = 0.005, SOV = 0.895, 2OV = 0.07, 3OV = 0.03. An Average occupancy of 20 passengers per bus and the "Medium" level of bus service were assumed. Also, the default modal shift parameters of the program were used.

Table 8 shows the results of the FREQ runs with bus services. The numbers show that the hypothetical bus service will significantly increase the benefit of the ramp metering with PE by converting drivers to buses. It needs to be stressed that FREQ only provides sketch-level capabilities for analyzing the effect of the bus service. Thus, a more detailed analysis using a travel demand forecasting model or similar tools need to be conducted to accurately estimate the benefit of the bus service on I-290/IL53.

Table 8. Simulation Results- 2030 Ramp Metering with Priority Entrance and Bus Service

Scenario		1	2	3	4	% change		
Mainline & Ramp	2002 base	2030 base	2030 ramp meter only	2030 ramp meter and spatial shift	2030 ramp meter, spatial and modal shift	4-1	3-1	2-1
Passenger hours	125,955	294,810	330,381	314,399	222,293	-24.6%	6.6%	12.1%
Total Vehicle miles traveled	4,930,839	5,040,485	5,058,348	5,028,746	4,976,171	-1.3%	-0.2%	0.4%
Total Gas consumption (gallons)	292,276	354,368	367,669	360,297	327,035	-7.7%	1.7%	3.8%
Total VOC (tons)	1,478	2,508	2,726	2,613	2,053	-18.1%	4.2%	8.7%

Figure 24 2030 with Ramp Meters with PE with Spatial and Mode Shift, with Bus Service ---
Inbound AM

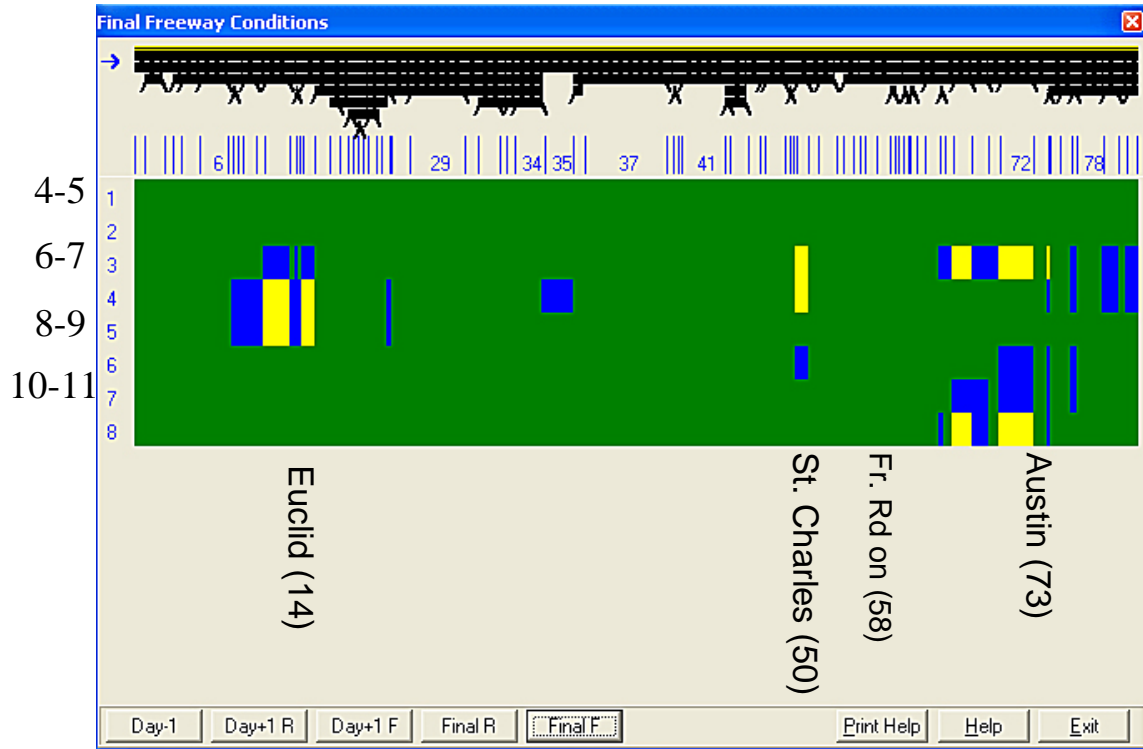
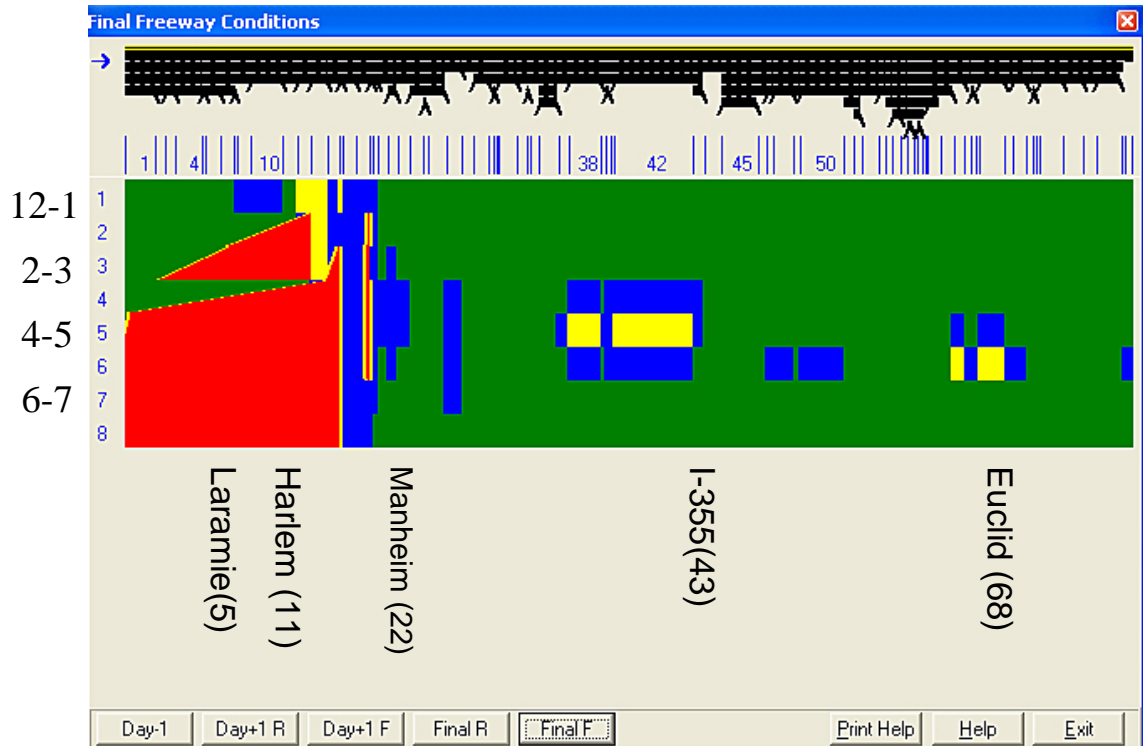


Figure 25 2030 with Ramp Meters with PE with Spatial and Mode Shift, with Bus Service ---
Outbound PM



VI. Conclusion

This study investigated the potential application of ramp metering with and without HOV priority entry (PE) lanes for the I-290 corridor. The analyses using FREQ and VISSIM programs estimated that ramp metering without HOV PE lanes will not improve the overall travel condition along the corridor significantly. With HOV PE lanes, however, ramp metering is expected to reduce total passenger travel time by 15.8 % for the 2030 condition along the mainline expressway and ramps. Vehicle miles traveled, fuel consumption, and total emission of volatile organic compound (VOC) are projected to decrease by 1.0%, 6.3%, and 15.0%, respectively. Additional analysis revealed that providing bus services on I-290/IL53 with PE will increase the benefit although more rigorous analysis will be needed to accurately estimate the quantity.

References:

American Highway Users Alliance. UNCLOGGING AMERICA'S ARTERIES - Effective Relief for Highway Bottlenecks 1999-2004. American Highway Users Alliance. Washington D.C. <http://www.highways.org/pdfs/bottleneck2004.pdf>

Cambridge Systematics, Inc. Twin Cities Ramp Meter Evaluation – Final Report. Prepared for Minnesota Department of Transportation, February 2001. <http://www.dot.state.mn.us/rampmeterstudy/pdf/finalreport/finalreport.pdf>

Cambridge Systematics, Inc. MN/DOT Ramp Metering Evaluation Report - Phase II Evaluation Report. Prepared for Minnesota Department of Transportation, May 2002.

Doenges, Dan. FREQ Simulation and Ramp Meter/HOV Bypass Optimization for the South Study Area: CATS Working Paper 01-21. Chicago Area Transportation Study. 2001

Schermann, Jon. FREQ Simulation and Ramp Meter/HOV Bypass Optimization for the Northwest Study Area: A Methodology for Determining Reasonable FREQ Volume Inputs: CATS Working Paper 05-02. Chicago Area Transportation Study. 2005

Transportation Research Board. Highway Capacity Manual 2000. Washington D.C.: Transportation Research Board, 2000.

Transportation Research Board. NCHRP Report 463 - Economic Implications of Congestion. Washington D.C., Transportation Research Board, 2001.

Federal Highway Administration (FHWA). Ramp Management and Control Handbook. Washington D.C.: US Department of Transportation, January 2006.

US DOT. Ramp Metering Status in North America. DOT - T - 95 - 17. Washington D.C.: US Department of Transportation, June 1995

Appendix 1: VISSIM Modeling

1. Introduction

The purpose of this report is to present the results of highway capacity estimation at some weaving sections in Eisenhower expressway in the west Chicago. This work is part of the analysis to determine the benefits of HOV bypass lane implementation on some on-ramps in the study area. In order to get a more accurate capacity at the weaving sections, a microscopic traffic simulation approach is chosen to get a highly realistic representation of the current traffic conditions for input to the FREQ model. The Hillside strangler, where Eisenhower expressway, Ronald Reagan Memorial tollway, and Tri-State tollway meet each other, is the focus of the VISSIM analysis. Five separate models for the weaving sections have been coded and calibrated for this purpose. In addition, another model for Eisenhower expressway from St Charles Rd to S 9th Ave has been calibrated for 2004 traffic flow data.

Maximum capacity of weaving sections is affected by many variables including, but not limited to, lane configuration and traffic flow. There are different ways to estimate the capacity such as statistical analysis, 2000 Highway Capacity Manual (1) charts, and traffic simulation. In this work, micro simulation approach is taken because other methods are not accurate enough for complex weaving sections. So it is considered that the capacity value may be reproduced by the aggregation of individual driver behaviors.

Parameters that control the maneuvers of weaving vehicles such as lane changing and acceptable gap which affect capacity were precisely calibrated in the basic model, the study area of which is shown in Figure 1. After calibrating the basic model, five weaving sections in Eisenhower expressway were pulled out and coded separately in order to estimate the maximum capacity of the sections. In the outbound direction, weaving sections between 17th and 25th Ave, 25th Ave and Mannheim Rd, and Mannheim Rd and Frontage Rd were modeled and similarly, in the inbound direction, weaving sections between Mannheim south on-ramp and Mannheim north off-ramp, and Mannheim Rd and 25th Ave were coded.

2. Approach

The freeway weaving section capacity estimation procedures in the HCM 2000 are based on research conducted in the early 1970s through the early 1980s (2). Recent research efforts have shown that the methods' ability to predict the operation of a weaving section is limited which is most probably due to the outdated methods that were utilized to develop these models. Other approaches such as traffic simulation and statistical analysis have been taken in the literature to get more accurate results.

VISSIM, a microscopic, time step and behavior based traffic simulation software, has been chosen to estimate the freeway capacity at the waving sections in this work. VISSIM can analyze traffic and transit operations under constraints such as lane configuration, traffic composition, traffic signals, transit stops, etc. VISSIM has applications in many areas such as the analysis of slow speed weaving and merging areas, simulating various types of signal control logic, comparison of design alternatives including signalized and stop sign controlled intersections, roundabouts and grade separated interchanges, etc.

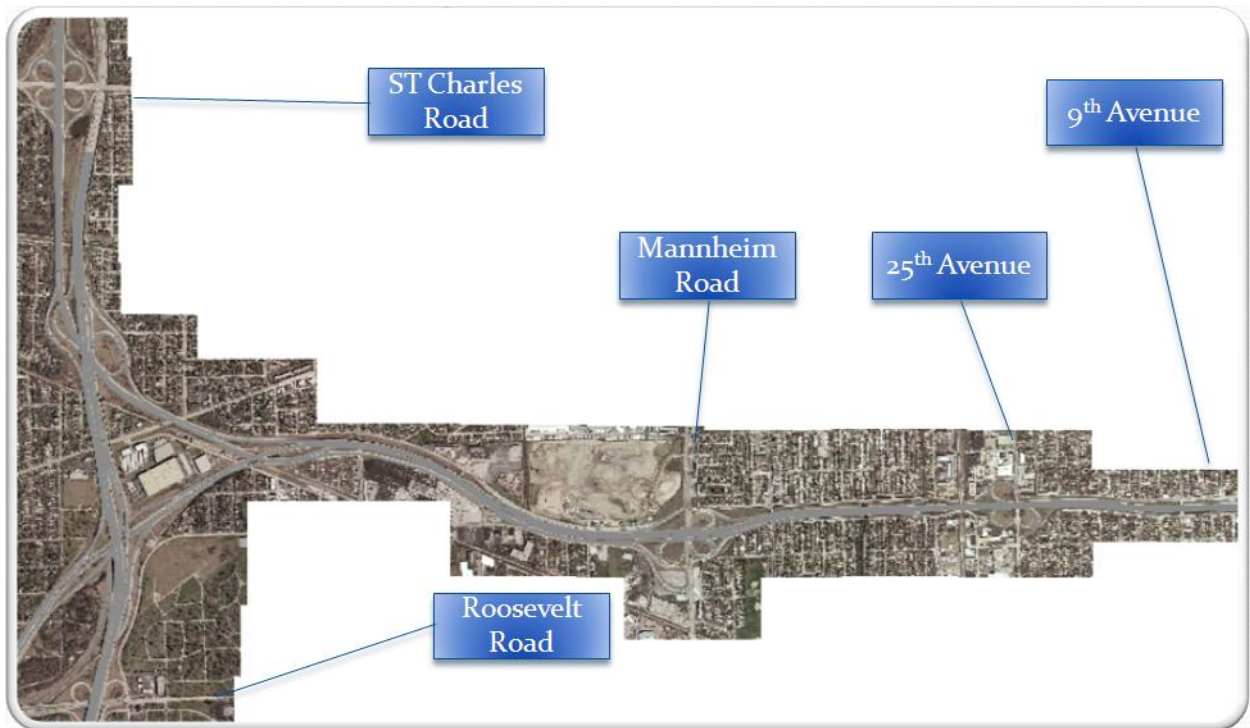


Figure 1. VISSIM Study Area in the Basic Model

In order to estimate the maximum capacity of a specific section of the freeway, we had to make sure that the capacity is not influenced by the downstream traffic flow. So after calibrating the parameters that control the maneuvers of weaving vehicles such as lane changing and acceptable gap in the basic model, each weaving section was pulled out and modeled separately. The downstream network was deleted and all the vehicles disappear after passing the weaving section. The initial traffic flow was set in a way that the vehicles reach the free flow speed at the weaving section and then the flow was increased gradually until the queue build up. The traffic flow at which the vehicles reach 85% of the free flow speed was taken as the maximum capacity (3). For each section the simulation was repeated several times until the speed-flow graph reaches a stable condition. Using the same approach, maximum capacity for each weaving section was estimated for input to the FREQ model.

3. Data Sources

To run the VISSIM traffic simulations, several data sources were used. In the basic network, hourly traffic volume for Eisenhower expressway and all the on/off ramps in the study area were obtained from the IDOT's Traffic Systems Center (TSC). Also, speed data for Eisenhower expressway received from TSC. Although the traffic counts are for 4 May 2004, speed data are for May 2007. Because the hourly speed data at TSC are kept only for two months and the traffic pattern and lane configuration in the study area has not been changed for the past couple of years, May 2007 data were used instead of May 2004 for the purpose of calibration.

On the other hand, for both Ronald Reagan Memorial tollway and Tri-State tollway the hourly traffic counts for 2004 were not available and these numbers had to be

approximated. For this purpose, average annual daily traffic (AADT) volumes were extracted from “2004 Illinois Data Report for the Illinois Tollway System” and distributed based on an hourly traffic distribution graph for highways, provided in HCM 2000.

All the data are for the AM and PM peak hour periods. There was no accident or adverse weather condition such as snow or rain for all these data collection days. Roadway geometry, number of lanes and other physical attributes of the highways are based on Google Map 2007 and some site observations.

4. Coding

Modeling the network in VISSIM has the following steps:

1. Set the simulation parameters such as traffic regulations, period of time to be simulated, starting time, etc.
2. Create/edit speed profiles. For any vehicle type the speed distribution is an important parameter that has a significant impact on freeway capacity and travel speeds.
3. Create traffic compositions. A traffic composition defines the vehicle mix of each input flow to be defined for the VISSIM network. 20% heavy vehicles were considered for the network.
4. Place and scale the background image file.
5. Draw links and connectors for roadways.
6. Enter traffic volumes at network endpoints.
7. Enter routing decision points and associated routes.
8. Enter priority rules for the merge points.
9. Run the simulation.

By coding the basic network and making reasonable adjustments to the original traffic routing decisions, lane change behavior parameters, vehicle following behavior parameters, and the simulation resolution, the basic model was calibrated. Having the basic model, coding the weaving sections was straightforward. Unnecessary links were removed and all the calibration parameters were kept unchanged. As described in section 2, initial traffic flow was set in a way that the vehicles reach the free flow speed at the weaving sections and then the flow was increased gradually until the queue build up. The traffic flow at which the vehicles reach 85% of the free flow speed was taken as the maximum capacity.

There are some key assumptions under which the study area is modeled:

1. All traffic inputs for Eisenhower expressway and on/off ramps were determined from the TSC data collected on 5/4/2004. Two exceptions are the exit ramp from east bound I-88 to Frontage road and also exit ramp from I-290 east bound to Frontage road. These traffic counts have been approximated in a rough and simple way. Having the traffic counts for I-290 east bound at Hillside and St. Charles stations and all the on and off ramps in between, traffic flow for the Frontage road exit ramp has been calculated. In the same way, the exit ramp from east bound I-88 to Frontage road has been estimated. Having the traffic counts for the east end of Frontage road, where it merge I-290, and all the on and off ramps all the way back to I-88, traffic flow for the Frontage road exit ramp from I-88 has been approximated.
2. For the tollway system, traffic counts were generated by distributing AADT values over an hourly traffic distribution graph for highways, provided in HCM 2000.

3. 20% heavy vehicles are considered in the traffic all over the network and it is assumed to be same as the composition at the FREQ model.
4. Traffic pattern in Eisenhower expressway is assumed to be almost unchanged from 2004 and speed data for 2007 have been used for calibration part.
5. At all the weaving sections that are modeled separately, the proportion of the mainline and the ramps are based on the average hourly data that were used in the basic model.
6. In the basic model, all the AM peak simulations run from 5 to 11. This could have a minor affect on the maximum capacity estimations because It would slightly change the simulation parameters and also the mainline and ramps traffic flow proportion at weaving sections in off peak hours.

5. Results

Calibration

Calibration is the process of making changes to a simulation model so that it accurately reflects the existing conditions. The VISSIM model consists of uncontrollable and controllable elements. The uncontrollable elements are those data or measurements that were collected in the field such as number of lanes, lane configuration, input traffic volume, traffic compositions, routing decisions, speed profile, etc. These data are not changeable for the calibration purpose. The controllable parameters are those that could be changed to reflect the real traffic condition. Some of the most important ones are as follow:

1. One of the basic parameters that users should consider at the beginning of calibration procedure is the *Lane Change Rule Parameters*. These parameters determine the location of lane change (Lane change parameter) at which vehicles will begin to attempt to change lanes and a final lane change (Emergency lane change parameter) that a vehicle stops in order to change lanes when a gap is not available on a neighboring lane due to a heavy traffic flow. These parameters are modified from the default values to realistic values and to avoid unrealistic queues.
2. The ten default freeway following behavior parameters are based on the Wiedemann 99 model. One of these parameters is the headway time that a driver tries to maintain the safety distance at a given speed. The safety distance in this model is the minimum distance a driver will keep while following a leading car. This value will affect the capacity significantly when traffic volume is high. This parameter is reduced from 0.9 to 0.6 seconds in the Eisenhower expressway model to better reflect the traffic condition and to increase the throughput numbers.
3. The simulation resolution is a number that defines how many times per simulation second a vehicles' position is calculated. The higher the number, the more realistic the model will be. In this model the resolution parameter was increased from 5 to 10 to better replicate the drivers' behavior.

In order to perform the calibration, certain criteria of the real-life situations are selected and then the model is modified until the outputs get close enough to the real observations. For this particular model, six measures are used for calibration. These are:

1. Traffic flow profile at Hillside and 9th avenue stations (in/outbound). As expected, the model results were pretty close to the real counts because the real traffic flow has been fed into the network.
2. Speed profile at Hillside (in/outbound) and 9th avenue stations (outbound). Because in the outbound direction the network is not expanded over 9th avenue, speed profile at this station would not be realistic. At this point all the vehicles are getting out of the network and there is no congestion at this point. So the peak hour drops in the real speed profile could not be replicated in the simulation. But the simulated speed profiles in the other stations are very close to the observed profiles. Figure 2 compares the observed and simulated speed profile at 9th avenue inbound station. Other stations have the similar closeness between the observed and simulated profiles.

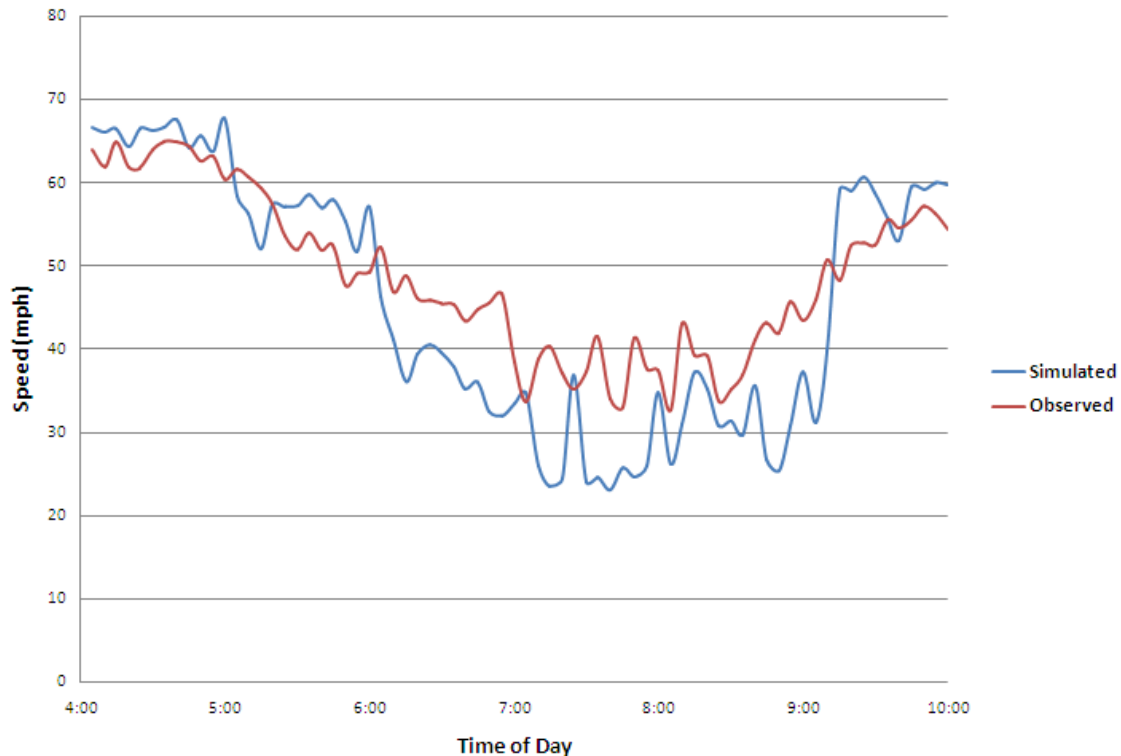


Figure 2. AM Peak Speed Profile for Outbound Eisenhower Expressway @ 9th Ave.

3. Queue length at some ramps and bottlenecks. Based on the previous observations, some critical ramps and bottleneck were recognized to be checked for the desired queue length. Two major ones are the point at which I-88 and I-290 merge in the inbound and also the merging point of Frontage road and I-290 inbound. The queue length was asked from the IDOT staffs who observe the live traffic from the cameras. Their experiences were close enough to the observed queues in the simulation runs. The calibration measures of this network are satisfactory and the basic simulation model can replicate the real traffic behavior. But as mentioned briefly before, this level of accuracy is more than enough for the purpose of maximum capacity estimation of the weaving sections. Although a slight change in the calibration parameters could improve the calibration criteria, this parameter change could have a negligible effect on the final capacity estimations. But this VISSIM model has been created not only for capacity

estimation at some complex weaving sections, but also for future studies on this area that might need to have a microscope traffic simulator.

Capacity Estimation

To estimate the maximum capacity of each weaving section, that was pulled out from the basic model and coded separately. Traffic flow initiated such that the vehicles reach the free flow speed at that section. By increasing the input flow, speed profile dropped and the volume, at which 85% of free flow speed was observed, was reported at maximum capacity. Typical speed-flow graph for the weaving section between 25th Ave and Mannheim Rd is shown in Figure 3. In this case, maximum capacity for each lane is 1575 vehicle/hr and the capacity of the whole section is 6300 vehicle/hr.

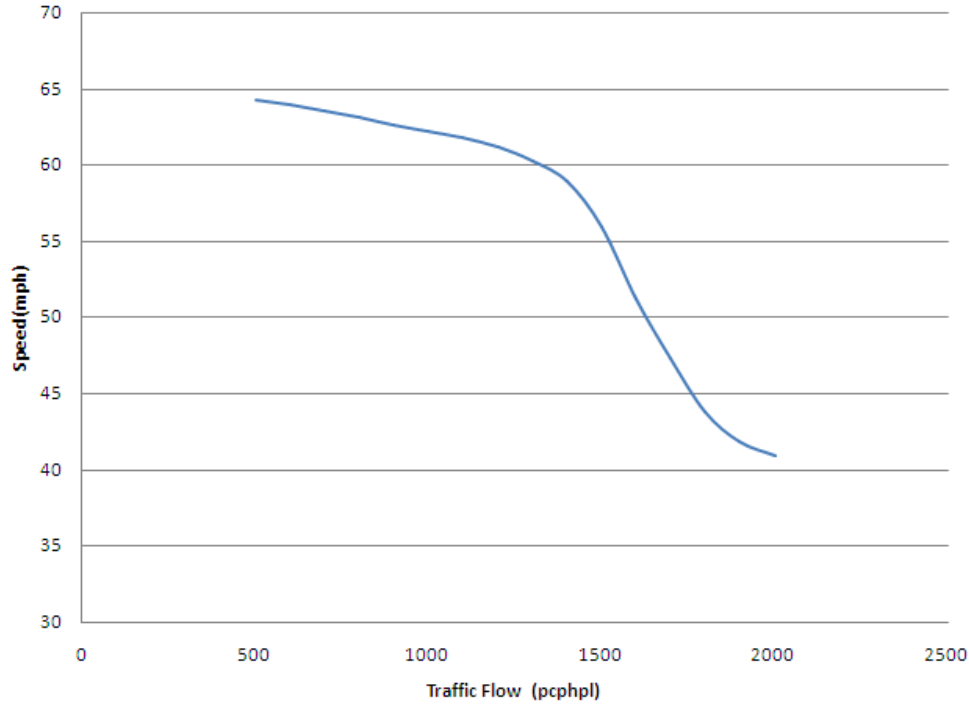


Figure 3. Speed-Traffic Flow for the Weaving Section between 25th Ave and Mannheim Rd.

Maximum capacity estimations for all the weaving sections are summarized in Table 1.

Table: Maximum Capacity Estimation Results

Weaving Section	Lane Capacity (pcphpl)	Section Capacity (pcph)
Outbound I-290, 17 th and 25 th Ave	1685	8425

Outbound I-290, 25th Ave and Mannheim Rd	1575	6300
Outbound I-290, Mannheim Rd and Frontage Rd	1315	5260
Inbound Frontage road, Mannheim south on-ramp and Mannheim north off- ramp	970	2910
Inbound I-290, Mannheim Rd and 25th Ave	1305	5220

6. References

1. Highway Capacity Manual (HCM) 2000 – Weaving Segments, Chapter 24, Transportation Research Board, National Research Council, Washington, D.C. 2000
2. Roess, R. and Ulerio, J., Weaving Area Analysis in Year 2000 Highway Capacity Manual, Transportation Research Record, n 1710, 2000, pp. 145-153.
3. Rakha, H. and Zhang, Y., Analytical Procedures for Estimating Capacity of Type B Weaving Sections, TRB 2008 Annual Meeting CD-Rom.

Appendix 2: Calibration Data

Austin Avenue - Independence Boulevard Ramp Volume Data (Week of March 1, and March 8, 2004)

EB I-290 Average Volume W/O 3/10 and 3/4

Time of Day	Austin Exit	Austin Entr	Central Exit	Central Entr	Laramie Entr	Cicero Exit	Kostner Entr	Indepdt Exit	Indepdt Entr
12:00am	254	166	253	136	141		349	196	292
1:00am	134	102	130	82	97		210	130	161
2:00am	100	80	94	63	71		182	98	109
3:00am	68	97	89	65	67		142	94	98
4:00am	81	198	100	127	103		183	142	105
5:00am	156	556	277	332	281		500	359	232
6:00am	185	1319	298	614	517		567	646	427
7:00am	153	1676	259	764	617		402	753	428
8:00am	161	1526	238	681	563		342	786	366
9:00am	257	1260	366	434	509		587	653	550
10:00am	378	904	384	449	494		666	618	595
11:00am	386	796	432	444	501		591	620	623
12:00pm	425	824	465	461	537		635	654	666
1:00pm	443	810	482	473	554		675	672	701
2:00pm	524	877	582	533	580		716	795	802
3:00pm	562	880	716	569	587		745	748	940
4:00pm	469	989	651	564	585		704	772	944
5:00pm	428	1020	498	487	566		639	665	812
6:00pm	444	1010	450	509	486		673	655	796
7:00pm	467	813	437	394	463		608	552	716
8:00pm	472	659	393	346	385		555	474	599
9:00pm	500	657	401	367	376		586	448	588
10:00pm	412	513	355	303	327		521	397	491
11:00pm	400	334	347	208	223		536	318	411
3.11.04	7859.75	18065	8693.5	9,401	9,626	12313.5	12,244	12449.5	9,753

- Arterial capacity and free flow speed

Inbound

SS	Cap	FFSPD
1 WB Lake-Cook Start	3096	40
2 EB Lake Cook On/Dundee	3096	40
3 Enter SSec Description	2880	45
4 Dundee Rd. On	2880	45
5 Rand On/WB Palatine Off	2880	40
6 Enter SSec Description	2880	40
7 WB Pala On/EB Pala Off	2880	40
8 Enter SSec Description	2880	40
9 EB Pala On/NW Hwy Off	2880	40
10 Enter SSec Description	3096	40
11 NW Hwy On/WB Euclid Off	3096	40
12 Enter SSec Description	4636	40
13 WB Euclid On/EB Euc. Off	4636	40
14 Enter SSec Description	4636	40
15 EB Euclid On	4636	40
16 Kirchoff on	3906	40
17 Algonquin off	3906	40
18 Enter SSec Description	7848	45
19 Algonquin on/WB I-90 off	7848	45
20 Enter SSec Description	7848	35
21 WB I-90 on/EB I-90 off	9625	35
22 Enter SSec Description	9625	35
23 EB I-90 on/Woodfield off	9626	35
24 Enter SSec Description	9626	35
25 Enter SSec Description	9626	35
26 Higgins Rd. off	9626	35
27 Enter SSec Description	8996	40
28 Higgins On/Biesterf. off	9356	40
29 Enter SSec Description	9756	40
30 Biesterf. on/Thornd. off	8820	40
31 Enter SSec Description	8820	40
32 WB Thorndale on	8820	40
33 EB Thorndale on/I-355 of	11380	40
34 Enter SSec Description	11380	40
35 NB I-355 on	11297	40
36 SB IL 83 off	11297	40
37 Enter SSec Description	13290	40

38	SB IL 83 on/NB IL 83 off	13290	40
39	Enter SSec Description	13290	40
40	NB IL 83 on	13083	40
41	York St. on & off	8250	45
42	EB North Ave. off	9489	45
43	Enter SSec Description	9489	40
44	WB North on	9489	40
45	EB North on/WB STC off	9489	40
46	Enter SSec Description	5310	40
47	WB STC on/EB STC off	5310	40
48	Enter SSec Description	5310	40
49	EB STC on/SB I-294 off	5310	40
50	Enter SSec Description	5643	40
51	SB I-294 on	5643	40
52	I-88 Merge (1)	5643	40
53	I-88 Merge (2)	5643	40
54	Hillside on/SB Man. off	4716	40
55	Enter SSec Description	5040	40
56	SB Man. on/NB Man. off	5040	40
57	Enter SSec Description	5040	40
58	NB Mannheim on	5040	40
59	SB 25th off	5040	40
60	Enter SSec Description	3013	40
61	Enter SSec Description	3013	40
62	SB 25th on/NB 25th off	3013	40
63	Enter SSec Description	3013	40
64	NB 25th on/17th Ave. off	3013	40
65	Enter SSec Description	3096	40
66	17th Ave. on	3096	40
67	9th on/1st off	3636	35
68	Enter SSec Description	3756	35
69	1st on/Des Plaines off	3756	35
70	Harlem Ave. off	2926	35
71	Enter SSec Description	1726	25
72	Harlem on/Austin off	1726	25
73	Enter SSec Description	1726	25
74	Austin Ave. on/Central off	1726	25
75	Enter SSec Description	2553	25
76	Central on/Laramie on	3807	25
77	Laramie on/Cicero off	2286	30
78	Enter SSec Description	3861	25
79	Kostner on.Indp. Off	2313	25
80	Enter SSec Description	2313	25
81	Indep. On	2313	25

Outbound

SS#	Old ss	Section	Cap	FFSPD
1		Start/Ind. Off	2286	25
2		Enter SSec Description	2286	25
3		Ind. On/Kostner off	2286	25
4		Enter SSec Description	2808	25
5		Cicero on/Laramie off	2523	25
6		Laramie off/Central off	4375	25
7		Enter SSec Description	2916	25
8		Cnetral on/Austin off	2916	25
9	1	Austin Start	1726	25
10	2	Austin on/Harlem off	1726	25
11	3	Enter SSec Description	1726	25
12	4	Harlem Ave. on	2926	35
13	5	Des Plaines on/1st off	3756	35
14	6	Enter SSec Description	3756	35
15	7	1st on/9th off	3636	35
16	8	17th Ave. off	3096	30
17	9	Enter SSec Description	3096	30
18	10	17th Ave on/NB 25th off	3013	35
19	11	SB 25th Ave. off	3013	35
20	12	Enter SSec Description	3013	35
21	13	25th on/Mann. off	5040	35
22	14	Enter SSec Description	5040	35
23	15	NB Mann on	5040	35
24	16	SB Mann On/Hillside Off	4716	35
25	17	I-88 Split	5643	40
26	18	NB I-294 off	5643	40
27	19	Enter SSec Description	5643	40
28	20	NB I-294 on/EB STC off	5310	40
29	21	Enter SSec Description	5310	40
30	22	EB STC on/WB STC off	5310	40
31	23	Enter SSec Description	5310	40
32	24	WB STC on/EB Lake off	9489	40
33	25	Enter SSec Description	9489	40
34	26	SB I-294 on/WB North off	9489	40
35	27	Enter SSec Description	9489	40
36	28	Lake-North on/WB Lake of	9489	40
37	29	Enter SSec Description	8250	45

38	30 York on/NB IL 83 off	13083	40
39	31 Enter SSec Description	13290	40
40	32 NB IL 83 on/SB IL 83 off	13290	40
41	33 Enter SSec Description	13290	40
42	34 SB IL 83 on	11297	40
43	35 SB I-355 off	11297	40
44	36	11380	40
45	37 I-355 merge/Thornd. off	10536	40
46	38 Enter SSec Description	13146	40
47	39 EB Thorndale Ave. on	8820	40
48	40 WB Thorn. on/Biest. off	8820	40
49	41 Enter SSec Description	9756	40
50	42 Biest. on	9756	40
51	43 Diverge	9266	40
52	44 Higgins Off	9266	40
53	45 Enter SSec Description	8996	40
54	46 Higgins on	9356	35
55	47 Diverge	9626	35
56	48 Woodfield on/I-90 off	9626	35
57	49 Enter SSec Description	9625	35
58	50 EB I-90 on/WB I-90 off	9625	35
59	51 Enter SSec Description	9625	35
60	52 WB I-90 on/Algonquin off	7848	35
61	53 Enter SSec Description	7848	45
62	54 Merge	7848	45
63	55 Algonquin on	4716	40
64	56 lane merge/Kirchoff off	4716	40
65	57 EB Euclid Ave. off	4636	40
66	58 Enter SSec Description	4636	40
67	59 EB Euclid on/WB Euc. off	4636	40
68	60 Enter SSec Description	4636	40
69	61 WB Euclid on/NW Hwy off	3096	40
70	62 Enter SSec Description	3096	40
71	63 NW Hwy on/EB Pala. off	2880	40
72	64 Enter SSec Description	2880	40
73	65 EB Pala. on/WB Pala. off	2880	40
74	66 Enter SSec Description	2880	40
75	67 WB Palatine on/Rand off	2880	40
76	68 IL Rt. 68/Dundee Rd. off	2880	45
77	69 Enter SSec Description	2880	45
78	70 Dundee on/EB LC off	3096	40
79	71 WB Lake Cook Off	3096	40
80	72 Final Merge	3096	40

- Calibration speed data (November and December, 2003)

Outbound

	GCM avg 5-6 am	GCM avg 6-7 am	GCM avg 7-8 am	GCM avg 8-9 am	GCM avg 9-10 am	GCM avg 10-11 am	GCM avg 11-noon	GCM avg noon-1	GCM avg 1-2 pm	GCM avg 2-3 pm	GCM avg 3-4 pm	GCM avg 4-5 pm	GCM avg 5-6 pm
Eisenhower Expressway/FRANKLIN	46	43	40	42	40	36	37	37	35	32	37	37	36
Eisenhower Expressway/CANAL*	55	55	51	54	53	49	50	49	45	47	47	43	43
Eisenhower Expressway/CIRCLE	55	55	55	55	55	55	55	54	52	54	55	51	50
Eisenhower Expressway/HALSTED STREET	55	55	55	55	55	55	55	55	55	55	55	55	44
Eisenhower Expressway/MORGAN STREET	55	55	55	55	55	53	55	54	50	52	53	51	28
Eisenhower Expressway/RACINE AVENUE	55	55	55	55	55	55	55	55	54	54	46	36	8
Eisenhower Expressway/PAULINA STREET	55	55	55	55	55	55	55	55	55	42	18	18	12
Eisenhower Expressway/NEW DAMEN MAINL	55	55	55	55	55	55	55	55	55	42	18	19	18
Eisenhower Expressway/OAKLEY BLVD.	55	55	55	55	55	55	55	55	49	30	10	11	11
Eisenhower Expressway/WESTERN AVENUE	55	55	55	55	55	55	55	55	47	25	12	9	11
Eisenhower Expressway/SACRAMENTO	55	55	55	55	55	55	55	55	42	22	12	10	12
Eisenhower Expressway/HOMAN AVENUE	55	55	55	55	55	54	55	55	40	21	12	11	12
Eisenhower Expressway/INDEPENDENCE	55	55	54	54	54	52	51	50	32	14	10	12	10
Eisenhower Expressway/KOSTNER AVENUE	55	55	55	55	55	54	55	55	31	14	11	11	11
Eisenhower Expressway/CICERO AVENUE	55	55	54	52	54	55	53	44	22	14	11	11	14
Eisenhower Expressway/LARAMIE AVENUE	55	55	36	33	45	55	49	35	21	14	13	11	16
Eisenhower Expressway/CENTRAL AVENUE	55	55	23	8	33	55	46	27	12	11	10	9	13
Eisenhower Expressway/AUSTIN BLVD.	53	48	26	16	33	46	36	23	18	18	15	14	19
Eisenhower Expressway/EAST	55	55	36	33	45	55	43	37	33	34	22	23	25
Eisenhower Expressway/HARLEM	49	43	23	18	30	48	36	32	17	23	16	16	15
Eisenhower Expressway/DESPLAINES AVEN	51	48	23	24	37	50	41	33	22	28	23	21	23
Eisenhower Expressway/DESPLAINES RIVE	49	44	30	43	44	44	42	35	33	39	33	27	31
Eisenhower Expressway/1ST AVENUE	55	55	40	55	55	55	50	46	39	51	46	30	34
Eisenhower Expressway/5TH AVENUE	45	42	31	39	39	40	37	33	28	35	33	25	29
Eisenhower Expressway/17TH AVENUE	55	53	45	53	53	53	51	47	48	48	46	27	29
Eisenhower Expressway/25TH AVENUE	55	51	44	55	53	49	49	44	44	46	42	28	29
Eisenhower Expressway/ADDISON CREEK	52	47	43	49	50	46	47	42	40	44	39	31	35
Eisenhower Expressway/EAST MANNHEIM	55	55	55	55	55	55	52	55	55	51	49	44	49
Eisenhower Expressway/WEST MANNHEIM	54	51	49	47	48	47	46	44	43	44	43	40	43
Eisenhower Expressway/HILLSIDE	55	55	55	55	55	55	55	55	54	55	55	54	55
Eisenhower Expressway/WOLF	53	50	53	49	50	50	50	47	43	49	49	43	51
Eisenhower Expressway/BUTTERFIELD	44	46	45	35	36	38	40	34	37	39	46	41	44
Eisenhower Expressway/SOUTH TRI-STATE	54	55	54	51	51	51	52	52	47	52	55	53	54
Eisenhower Expressway/MAPLELEAF	41	42	42	40	37	35	37	33	35	38	43	39	39
Eisenhower Expressway/SOUTH ST. CHARL	43	45	45	49	42	34	38	33	37	40	45	42	42
Eisenhower Expressway/NORTH ST. CHARL	43	43	42	51	43	32	35	31	33	37	43	39	37
Eisenhower Expressway/C & NW RR	55	55	55	55	55	50	55	55	53	54	55	55	51
Eisenhower Expressway/SOUTH OF NORTH	42	45	46	52	45	35	35	35	34	38	42	41	34
Eisenhower Expressway/NORTH OF NORTH	44	42	42	54	46	37	37	37	35	39	42	42	40
Eisenhower Expressway/EMROY	43	46	49	49	43	38	37	38	38	41	44	38	30
Eisenhower Expressway/EAST YORK	42	42	45	46	41	36	35	37	35	38	41	32	21
Eisenhower Expressway/NORTH LAKE STRE	43	43	49	51	44	38	38	39	38	41	44	31	22
Eisenhower Expressway/EAST CHURCH	53	52	55	55	51	42	43	46	43	49	51	35	26
Eisenhower Expressway/EAST GRAND	43	44	45	52	47	35	37	41	38	39	41	28	23
Eisenhower Expressway/EAST RT. 83	48	49	52	55	49	40	41	42	41	45	47	31	24
Eisenhower Expressway/WEST RT. 83	44	44	47	51	46	37	38	41	39	41	44	28	22
Eisenhower Expressway/WOODDALE	43	43	45	51	46	36	38	40	37	40	42	31	30
Eisenhower Expressway/WEST WOODDALE	41	39	42	42	40	35	37	37	35	39	41	32	32
Eisenhower Expressway/ADDISON	47	45	48	50	46	39	42	41	39	43	46	32	35
Eisenhower Expressway/WEST ADDISON	50	51	54	53	49	43	46	46	42	48	53	37	44
Eisenhower Expressway/MILL ROAD	47	46	48	53	48	38	39	41	39	43	44	31	39
Eisenhower Expressway/EAST RT. 53	42	40	49	41	38	38	33	37	35	43	41	31	35
Eisenhower Expressway/NORDIC ROAD	42	45	49	49	46	40	41	43	40	45	45	48	51

	GCM avg 5-6 am	GCM avg 6-7 am	GCM avg 7-8 am	GCM avg 8-9 am	GCM avg 9-10 am	GCM avg 10-11 am	GCM avg 11-noon	GCM avg noon-1	GCM avg 1-2 pm	GCM avg 2-3 pm	GCM avg 3-4 pm	GCM avg 4-5 pm	GCM avg 5-6 pm
I-290/NORTH OF ARMY TRAIL CS L2 (KING	54	52	53	55	52	51	50	50	49	49	49	42	35
I-290/SOUTH OF LAKE STREET LANE 2	41	42	44	49	46	41	42	46	45	37	41	43	45
I-290/NORTH OF LAKE STREET LANE 2	52	54	48	45	46	42	45	47	43	50	52	49	50
I-290/SOUTH OF NORDIC RD LANE 2 (SCH	55	55	55	55	55	51	54	55	54	54	55	55	55
I-290/NORDIC ROAD CS L2 MATCH I290/I3	55	55	55	55	55	55	55	55	55	55	55	55	55
I-290/SOUTH OF IRVING PARK L2 (FAA)	55	55	55	55	55	55	55	55	55	53	55	49	38
I-290/IRVING PARK ROAD LANE 2	42	43	48	51	51	47	49	45	40	43	48	40	33
I-290/NORTH OF IRVING ROAD LANE 2	47	55	55	55	55	50	53	54	47	53	54	47	37
I-290/SOUTH OF THORNDALE LANE 2	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	49	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/NORTH OF THORNDALE LANE 2	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/DEVON AVENUE LANE 2	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/NORTH OF DEVON AVENUE LANE 2	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/BIESTERFIELD ROAD LANE 2	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/NORTH OF BIESTERFIELD ROAD LANE	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/1 MILE N. OF BIESTERFIELD L2 (WG	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/1 1/2 MILES S. OF HIGGINS L2 (O	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/1 MILE S. OF HIGGINS ROAD LANE	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/HIGGINS ROAD LANE 2 (SOUTH OF)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/NORTH OF HIGGINS ROAD LANE 2	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/WOODFIELD DRIVE LANE 2 EXPRESS	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/NORTHWEST TOLLWAY L2 EXPRESS CS	55	52	53	55	55	53	51	55	55	54	54	53	52
I-290/NORTH OF NORTHWEST TOLL L2 EXPR	55	55	55	55	55	54	53	55	55	55	55	54	54
I-290/ALGONQUIN ROAD LANE 2 EXPRESS	55	55	52	54	54	54	52	55	55	54	55	53	41
I-290/1/2 MILE NORTH OF ALGONQUIN ROA	55	55	35	55	55	55	55	55	55	55	55	49	24
I-290/KIRCHOFF ROAD LANE 2	55	55	47	54	55	55	55	55	55	55	55	50	44
I-290/SOUTH OF EUCLID AVENUE LANE 2	55	55	55	55	55	55	55	55	55	55	55	55	54
I-290/EUCLID AVENUE LANE 2 (NORTH OF)	55	55	55	55	55	55	55	55	55	55	55	55	55
I-290/1/2 MILE N. OF EUCLID L2 (INDUS	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	55	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/NORTHWEST HIGHWAY LANE 2 CS	29	30	35	39	41	40	37	31	31	39	47	38	36
I-290/SOUTH OF PALATINE ROAD LANE 2	55	55	55	55	55	48	55	55	55	55	55	55	55
I-290/NORTH OF PALATINE ROAD LANE 2	55	55	55	55	55	54	55	55	55	55	55	55	55
I-290/SOUTH OF RAND ROAD LANE 2 (ANDE	19	19	20	19	28	40	29	19	20	30	41	25	19
I-290/RAND ROAD LANE 2	55	55	55	55	55	44	55	55	55	55	55	55	55
I-290/SOUTH OF DUNDEE ROAD LANE 2	41	40	19	37	36	42	37	41	30	38	38	36	30
I-290/NORTH OF DUNDEE ROAD LANE 2 CS	55	52	55	43	48	47	53	51	51	51	51	48	52
I-290/1/2 MILE SOUTH OF LAKE-COOK ROA	55	55	55	55	55	54	55	55	55	55	54	49	55

Inbound

	GCM avg 5-6 am	GCM avg 6-7 am	GCM avg 7-8 am	GCM avg 8-9 am	GCM avg 9-10 am	GCM avg 10-11 am	GCM avg 11-noon	GCM avg noon-1	GCM avg 1-2 pm	GCM avg 2-3 pm	GCM avg 3-4 pm	GCM avg 4-5 pm	GCM avg 5-6 pm
Eisenhower Expressway/F A A	52	52	55	55	53	46	43	45	43	51	54	47	44
Eisenhower Expressway/NORDIC ROAD	55	55	55	55	55	55	55	55	55	55	55	55	55
Eisenhower Expressway/EAST OF RT. 53	55	54	55	55	55	52	54	53	51	53	55	52	51
Eisenhower Expressway/MILL ROAD	49	47	51	43	44	43	45	44	41	47	50	42	45
Eisenhower Expressway/WEST ADDISON	52	51	54	52	48	42	43	46	42	48	51	35	43
Eisenhower Expressway/ADDISON	47	46	49	46	44	38	39	40	37	43	45	33	40
Eisenhower Expressway/WEST WOODDALE	51	52	55	51	48	42	42	44	41	47	50	37	45
Eisenhower Expressway/WOODDALE	40	47	51	54	49	39	40	41	38	44	46	34	40
Eisenhower Expressway/WEST RT. 83	36	49	52	53	48	37	39	40	35	44	45	29	40
Eisenhower Expressway/EAST RT. 83	34	47	49	52	47	35	36	38	35	40	39	28	36
Eisenhower Expressway/EAST GRAND	30	41	42	44	40	32	33	35	31	36	33	24	34
Eisenhower Expressway/EAST CHURCH	36	52	51	43	42	37	38	40	38	44	38	28	40
Eisenhower Expressway/WEST YORK	33	39	37	38	36	31	32	32	30	30	25	18	31
Eisenhower Expressway/EAST YORK	43	44	41	46	41	33	34	34	32	28	25	18	35
Eisenhower Expressway/EMROY	44	44	42	53	46	34	34	34	33	27	19	16	32
Eisenhower Expressway/NORTH OF NORTH	45	45	43	50	44	35	35	35	34	26	16	14	18
Eisenhower Expressway/SOUTH OF NORTH	50	51	48	51	46	37	38	39	35	28	18	10	13
Eisenhower Expressway/C & NW RR	44	42	41	40	36	37	33	29	22	21	17	12	13
Eisenhower Expressway/NORTH ST. CHARL	45	46	36	43	34	37	38	30	21	24	16	16	15
Eisenhower Expressway/SOUTH ST. CHARL	43	43	31	42	32	34	37	29	21	23	16	14	14
Eisenhower Expressway/MAPLELEAF	44	43	29	36	28	33	34	28	24	23	16	16	17
Eisenhower Expressway/NORTH TRI-STATE	41	44	44	42	36	34	36	36	34	38	43	40	42
Eisenhower Expressway/BUTTERFIELD	55	55	55	55	52	54	54	54	48	52	55	54	54
Eisenhower Expressway/(WOLF) FROM EIS	48	46	45	55	46	38	38	39	36	39	48	41	42
Eisenhower Expressway/HILL SIDE COUNT	55	55	55	55	48	53	53	54	44	42	31	25	7
Eisenhower Expressway/WEST MANNHEIM	55	55	55	55	38	46	49	55	24	32	17	21	7
Eisenhower Expressway/EAST MANNHEIM	55	53	43	55	34	39	40	48	22	27	17	20	7
Eisenhower Expressway/ADDISON CREEK	55	40	10	13	13	31	38	35	23	25	11	11	6
Eisenhower Expressway/25TH AVENUE	54	42	13	11	18	32	41	39	26	26	15	10	7
Eisenhower Expressway/17TH AVENUE	55	46	15	25	29	29	39	38	28	27	14	11	9
Eisenhower Expressway/9TH AVENUE	52	36	19	6	15	30	35	34	25	22	17	12	11
Eisenhower Expressway/1ST AVENUE	55	41	19	11	17	28	31	33	24	21	19	17	14
Eisenhower Expressway/DESPLAINES RIVE	55	55	43	39	45	55	55	53	49	49	55	44	39
Eisenhower Expressway/DESPLAINES AVEN	55	55	31	15	23	45	43	45	41	41	51	31	26
Eisenhower Expressway/WEST HARLEM	53	50	23	9	17	40	45	41	36	37	48	23	21
Eisenhower Expressway/EAST HARLEM	55	51	19	8	14	39	47	44	34	40	50	20	19
Eisenhower Expressway/EAST AVENUE	53	50	30	11	23	41	44	37	38	43	44	42	45
Eisenhower Expressway/WEST AUSTIN	54	52	31	29	36	45	44	44	40	48	50	49	50
Eisenhower Expressway/EAST AUSTIN	55	55	30	9	29	55	55	54	48	53	55	52	54
Eisenhower Expressway/CENTRAL	55	55	30	20	39	55	55	55	54	55	55	55	55
Eisenhower Expressway/LARAMIE	55	55	21	33	45	55	55	55	54	54	55	55	55
Eisenhower Expressway/CICERO	55	55	38	42	49	55	55	55	55	55	55	55	55
Eisenhower Expressway/KOSTNER	55	55	29	33	44	55	55	55	55	55	55	55	55
Eisenhower Expressway/WEST INDEPENDEN	55	55	31	17	34	54	55	54	50	53	55	52	53
Eisenhower Expressway/EAST INDEPENDEN	55	55	37	36	46	55	55	55	55	55	55	54	54
Eisenhower Expressway/HOMAN	55	55	35	45	49	55	55	55	52	54	55	47	42
Eisenhower Expressway/SACRAMENTO	55	55	41	50	53	55	55	55	54	54	55	46	43
Eisenhower Expressway/CALIFORNIA	55	55	39	35	43	55	55	55	50	53	55	40	38
Eisenhower Expressway/OAKLEY	55	55	50	49	51	55	55	54	50	53	55	37	35
Eisenhower Expressway/HOYNE AVE. (NEW	55	55	55	55	55	55	55	55	53	54	55	38	30
Eisenhower Expressway/DAMEN	55	55	53	54	53	55	55	55	51	50	55	36	25
Eisenhower Expressway/DASHLAND	55	55	54	52	53	55	55	55	47	46	51	29	22
Eisenhower Expressway/WEST RACINE	55	55	55	53	54	55	55	53	47	46	48	30	26
Eisenhower Expressway/EAST RACINE	55	55	54	55	55	55	55	53	46	46	43	33	24
Eisenhower Expressway/HALSTED	55	55	55	55	55	53	54	54	54	55	54	53	54
Eisenhower Expressway/CIRCLE	55	55	55	55	55	55	55	55	53	54	54	52	51
Eisenhower Expressway/CANAL*	55	55	51	52	52	53	54	54	49	52	53	50	49
Eisenhower Expressway/FRANKLIN	35	31	18	29	26	30	30	34	32	31	30	28	28

	GCM avg	GCM avg	GCM avg	GCM avg	GCM avg	GCM avg	GCM avg	GCM avg	GCM avg	GCM avg	GCM avg	GCM avg	GCM avg
	5-6 am	6-7 am	7-8 am	8-9 am	9-10 am	10-11 am	11-noon	noon-1	1-2 pm	2-3 pm	3-4 pm	4-5 pm	5-6 pm
I-290/1/2 MILE SOUTH OF LAKE-COOK RD	55	55	55	55	55	50	55	55	55	55	55	55	55
I-290/NORTH OF DUNDEE ROAD CS LANE 2	55	55	55	55	55	55	55	55	55	55	55	55	55
I-290/SOUTH OF DUNDEE ROAD LANE 2	52	48	47	45	44	49	45	47	49	44	47	45	37
I-290/RAND ROAD LANE 2	55	55	54	53	52	51	55	55	55	53	55	34	17
I-290/SOUTH OF RAND ROAD (ANDERSON D	55	55	55	55	55	55	55	55	55	55	55	34	24
I-290/NORTH OF PALATINE ROAD LANE 2	55	55	41	55	53	52	53	54	55	51	51	26	18
I-290/SOUTH OF PALATINE ROAD LANE 2	55	55	40	55	55	53	55	55	55	55	55	33	25
I-290/NORTHWEST HIGHWAY CS LANE 2	53	55	43	26	36	51	49	52	52	48	38	31	22
I-290/1/2 MILE NORTH OF EUCLID (INDUS	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	49	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/EUCLID AVENUE (NORTH OF)	55	55	50	46	51	55	55	55	55	55	54	36	36
I-290/SOUTH OF EUCLID AVENUE LANE 2	55	55	50	46	51	55	55	55	55	55	54	37	37
I-290/KIRCHOFF ROAD LANE 2	55	55	51	43	49	55	55	55	54	55	53	43	43
I-290/1/2 MILE NORTH OF ALGONQUIN ROA	55	55	55	55	55	55	55	55	55	55	55	51	51
I-290/ALGONQUIN ROAD LANE 2 EXPRESS	55	55	55	54	52	50	55	53	53	54	55	54	55
I-290/NORTH OF NORTHWEST TOLL LANE 2	55	55	55	55	53	55	50	53	55	54	55	55	55
I-290/NORTHWEST TOLLWAY EXPRESS CS LA	46	49	42	38	39	40	44	41	43	43	44	43	43
I-290/WOODFIELD DRIVE EXPRESS LANE 2	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	44	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/NORTH OF HIGGINS ROAD LANE 2	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/HIGGINS ROAD LANE 2 (SOUTH OF)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/1MILE SOUTH OF HIGGINS ROAD LAN	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/1 1/2 MILES S. OF HIGGINS L2 (O	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/1 MILE NORTH OF BIESTERFIELD L2	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/NORTH OF BIESTERFIELD ROAD LANE	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/BIESTERFIELD ROAD LANE 2	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/NORTH OF DEVON AVENUE LANE 2	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/DEVON AVENUE LANE 2	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/NORTH OF THORNDALE AVENUE LANE	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/SOUTH OF THORNDALE AVENUE LANE	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290/NORTH OF IRVING PARK ROAD LANE	55	55	55	53	54	55	55	55	51	53	55	54	54
I-290/IRVING PARK ROAD LANE 2	53	53	54	55	55	50	50	50	48	52	50	51	48
I-290/SOUTH OF IRVING PARK LANE 2 (FA	47	53	54	53	54	49	48	44	46	49	47	47	55
I-290/NORDIC ROAD MATCH POINT I290/I3	47	42	49	44	40	43	35	40	37	38	40	38	35
I-290/SOUTH OF NORDIC ROAD LANE 2 (SC	55	55	55	55	55	50	54	55	54	53	52	42	33
I-290/NORTH OF LAKE STREET LANE 2	49	43	44	41	39	45	43	43	38	41	42	34	29
I-290/SOUTH OF LAKE STREET LANE 2	55	55	55	55	55	47	52	47	49	52	51	41	33
I-290/NORTH OF ARMY TRAIL RD CS L2 (K	55	55	55	53	53	53	53	53	53	52	55	54	55
I-290 Local Lanes/WOODFIELD DRIVE LAN	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	55	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
I-290 Local Lanes/NORTHWEST TOLLWAY L	55	53	43	55	55	53	54	55	55	52	51	30	22
I-290 Local Lanes/NORTH OF NORTHWEST	55	55	55	55	55	54	55	55	55	55	55	55	55
I-290 Local Lanes/ALGONQUIN ROAD LANE	51	50	26	40	43	48	46	46	44	45	47	45	24
I-290 Local Lanes/ALGONQUIN ROAD LANE	55	54	53	55	53	51	52	53	51	49	48	28	16
I-290 Local Lanes/NORTH OF NORTHWEST	55	55	55	55	55	54	55	55	55	54	55	54	53
I-290 Local Lanes/NORTHWEST TOLLWAY L	55	55	55	55	55	54	55	55	54	54	55	55	54
I-290 Local Lanes/WOODFIELD DRIVE LAN	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	55	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Calibration notes

Inbound

Revisions made to FREQ files

Original file	Revised file	Revisions
Ike_IB_AM_JS_17.frq	Ike_IBAM_JS17_81-Artvol-07b.frq	<ul style="list-style-type: none">• Added parallel arterials (see Arterial_Volume_NW_Study_Area_IBAM_KK-2.xls)• Added Independence Blvd to Austin sections (see ramp vols_290_austin to indp bl_March 04_six days_IB_KK-rev.xls)• Reconfigured Dundee Interchange• Reconfigured Strangler Interchange (see Demand3_Amir_split.xls and NW_Study_Area_IBAM_12_12_07.xls for volume calculation)• Re-calibrated the entire study area
Ike_IB_PM_JS_02.frq	Ike_IBPM_JS02_81-artvol-07b.frq	<ul style="list-style-type: none">• Added parallel arterials (see Arterial_Volume_NW_Study_Area_IBPM_KK-2.xls)• Added Independence Blvd to Austin sections (see ramp vols_290_austin to indp bl_March 04_six days_IB_KK-rev.xls)• Reconfigured Dundee Interchange• Reconfigured Strangler Interchange (see Demand3_Amir_split.xls and NW_Study_Area_IBAM_12_12_07.xls for volume calculation)• Re-calibrated the entire study area

Outbound

Revisions made to FREQ files

Base file	Calibrated file	Revisions
Ike_OB_AM_JS01.frq	Ike_OBAM_JS01_81-Artvol-07.frq	<ul style="list-style-type: none">• Added parallel arterials (see Arterial_Volume_NW_Study_Area_OBAM_KK-2.xls)• Added Independence Blvd to Austin sections (see ramp vols_290_austin to indp bl_March 04_six days_OB_KK-rev.xls)• Revised Austin ent. & D39 volumes (see ramp vols_290_austin to indp bl_March 04_six days_OB_KK-rev.xls)• Calibrated the entire corridor. Numerous adjustments were made to capacities.• Revised the speed limit to 55mph b/w Indep. Blvd, and I-88.
Ike_OB_PM_JS01.frq	Ike_OBPM_JS01_81_artvol-07.frq	<ul style="list-style-type: none">• Added parallel arterials (see Arterial_Volume_NW_Study_Area_OBPM_KK-2.xls)• Added Independence Blvd to Austin sections (see ramp vols_290_austin to indp bl_March 04_six days_OB_KK-rev.xls)• Calibrated the entire corridor. Numerous adjustments were made to capacities.• Revised the speed limit to 55mph b/w Indep. Blvd, and I-88.

2002 IBAM

[illegible]

2002 IBPM

[illegible]

2002 OBAM

[illegible]

2002 OBPM

[illegible]

Appendix 3: Simulation Results

2002 Base

Mainline	Inbound AM			Outbound AM			Inbound PM			Outbound PM			Total		
	Freeway	Ramp	Total	Freeway	Ramp	Total	Freeway	Ramp	Total	Freeway	Ramp	Total	Freeway	Ramp	Total
Passenger hours	25647	1506	27153	25316	496	25812	33403	6397	39800	33178	12	33190	117544	8411	125955
Total Vehicle miles traveled	1022733			1179876			1295871			1432359			4930839		
Total Gas consumption (gallons)	64506			64670			84386			78714			292276		
Total VOC (tons)	387			243			543			305			1478		

Arterial	Inbound AM		Outbound AM		Inbound PM		Outbound PM		Total
	Freeway	Ramp	Freeway	Ramp	Freeway	Ramp	Freeway	Ramp	
Passenger hours	49195		39864		53025		37142		179226
Total Vehicle miles traveled	671872		671659		765540		782561		2891632
Total Gas consumption (gallons)	828053		649321		42466		193240		1713080
Total VOC (tons)	212		225		183		205		825

2030 Base

	Inbound AM			Outbound AM			Inbound PM			Outbound PM			Total		
Mainline	Freeway	Ramp	Total	Freeway	Ramp	Total	Freeway	Ramp	Total	Freeway	Ramp	Total	Freeway	Ramp	Total
Passenger hours	30,743	21,967	52,710	46,255	28,423	74,678	50,518	11,326	61,844	51,828	30,999	82,827	179,344	92,715	272,059
Total Vehicle miles traveled	1,076,242			1,236,091			1,304,967			1,423,185			5,040,485		
Total Gas consumption (gallons)	78,074			85,631			93,091			97,571			354,367		
Total VOC (tons)	592			582			681			653			2,508		

Arterial	Inbound AM		Outbound AM		Inbound PM		Outbound PM		Total
Passenger hours	37,876		29,717		42,542		29,498		139,633
Total Vehicle miles traveled	671,872		671,659		765,540		782,561		2,891,632
Total Gas consumption (gallons)	389,371		538,190		348,578		120,901		1,397,040
Total VOC (tons)	165		186		204		176		731

2030 With Ramp Meter without Spatial Shift

Mainline	Inbound AM			Outbound AM			Inbound PM			Outbound PM			Total		
	Freeway	Ramp	Total	Freeway	Ramp	Total	Freeway	Ramp	Total	Freeway	Ramp	Total	Freeway	Ramp	Total
Passenger hours	24864	30010	54874	43812	34084	77896	42902	22913	65815	50190	32858	83048	161768	119865	281633
Total Vehicle miles traveled	1078313			1234347			1313248			1422396			5048304		
Total Gas consumption (gallons)	78778			86844			94777			97687			358086		
Total VOC (tons)	594			603			712			653			2562		

Arterial	Inbound AM		Outbound AM		Inbound PM		Outbound PM		Total
Passenger hours	38228		29717		42542		29498		139985
Total Vehicle miles traveled	676522		671659		765540		782561		2896282
Total Gas consumption (gallons)	384163		538190		348578		120901		1391832
Total VOC (tons)	168		186		204		176		734

2030 With Ramp Meter with Spatial Shift

Mainline	Inbound AM			Outbound AM			Inbound PM			Outbound PM			Total		
	Freeway	Ramp	Total	Freeway	Ramp	Total	Freeway	Ramp	Total	Freeway	Ramp	Total	Freeway	Ramp	Total
Passenger hours	24657	25894	50551	41842	30343	72185	43759	15171	58930	50057	31055	81112	160315	102463	262778
Total Vehicle miles traveled	1073905			1242354			1303352			1418717			5038328		
Total Gas consumption (gallons)	76724			85085			91550			96966			350325		
Total VOC (tons)	560			567			655			642			2424		

Arterial	Inbound AM		Outbound AM		Inbound PM		Outbound PM		Total
Passenger hours	37876		29887		43349		29670		140782
Total Vehicle miles traveled	671872		675993		780470		786242		2914577
Total Gas consumption (gallons)	389371		538452		361828		121131		1410782
Total VOC (tons)	165		187		209		177		738

2030 With HOV Priority Entry Ramp Meter without Spatial Shift

Arterial	Inbound AM	Outbound AM	Inbound PM	Outbound PM	Total
Passenger hours	37876	29717	42542	29498	139633
Total Vehicle miles traveled	671872	671659	765540	782561	2891632
Total Gas consumption (gallons)	389371	538190	348578	120901	1397040
Total VOC (tons)	165	186	204	176	731

2030 With HOV Priority Entry Ramp Meter with Spatial Shift

Mainline	Inbound AM			Outbound AM			Inbound PM			Outbound PM			Total		
	Freeway	Ramp	Total	Freeway	Ramp	Total	Freeway	Ramp	Total	Freeway	Ramp	Total	Freeway	Ramp	Total
Passenger hours	20943	29888	50831	39251	39635	78886	31718	38427	70145	47176	43032	90208	139088	150982	290070
Total Vehicle miles traveled	1077842			1245933			1283566			1420215			5027556		
Total Gas consumption (gallons)	77384			87398			95521			99945			360248		
Total VOC (tons)	569			607			742			694			2612		

Arterial	Inbound AM		Outbound AM		Inbound PM		Outbound PM		Total
Passenger hours	39814		30461		44765		30178		145218
Total Vehicle miles traveled	678331		677479		779224		789635		2924669
Total Gas consumption (gallons)	375574		528776		351283		256605		1512238
Total VOC (tons)	169		189		210		180		748

2030 With HOV Priority Entry Ramp Meter with Spatial and Mode Shift

Mainline	Inbound AM			Outbound AM			Inbound PM			Outbound PM			Total		
	Freeway	Ramp	Total	Freeway	Ramp	Total	Freeway	Ramp	Total	Freeway	Ramp	Total	Freeway	Ramp	Total
Passenger hours	20388	20566	40954	35063	32602	67665	26196	13425	39621	45970	34954	80924	127617	101547	229164
Total Vehicle miles traveled	1052196			1236436			1274035			1429842			4992509		
Total Gas consumption (gallons)	71812			81851			82155			96351			332169		
Total VOC (tons)	487			514			507			624			2132		

Arterial	Inbound AM		Outbound AM		Inbound PM		Outbound PM		Total	
	Freeway	Ramp	Freeway	Ramp	Freeway	Ramp	Freeway	Ramp	Freeway	Ramp
Passenger hours	39814		30461		44765		30178		145218	
Total Vehicle miles traveled	678331		677479		779224		789635		2924669	
Total Gas consumption (gallons)	375574		528776		351283		256605		1512238	
Total VOC (tons)	169		189		210		180		748	

Appendix 4:
FREQ Analysis Graphics for All Directions and Times

Inbound AM
Inbound PM – not in main text
Outbound AM – not in main text
Outbound PM

Inbound AM

Figure 1. 2030 Base Condition - Inbound AM

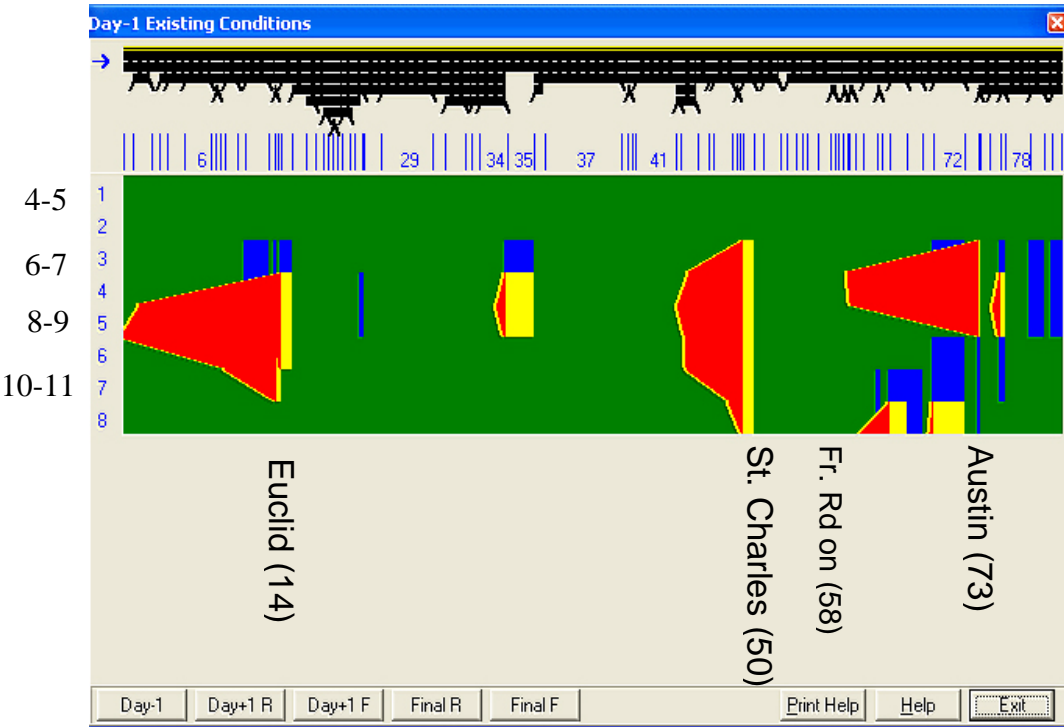


Figure 2. 2030 with Ramp Meters without Spatial Shift - Inbound AM

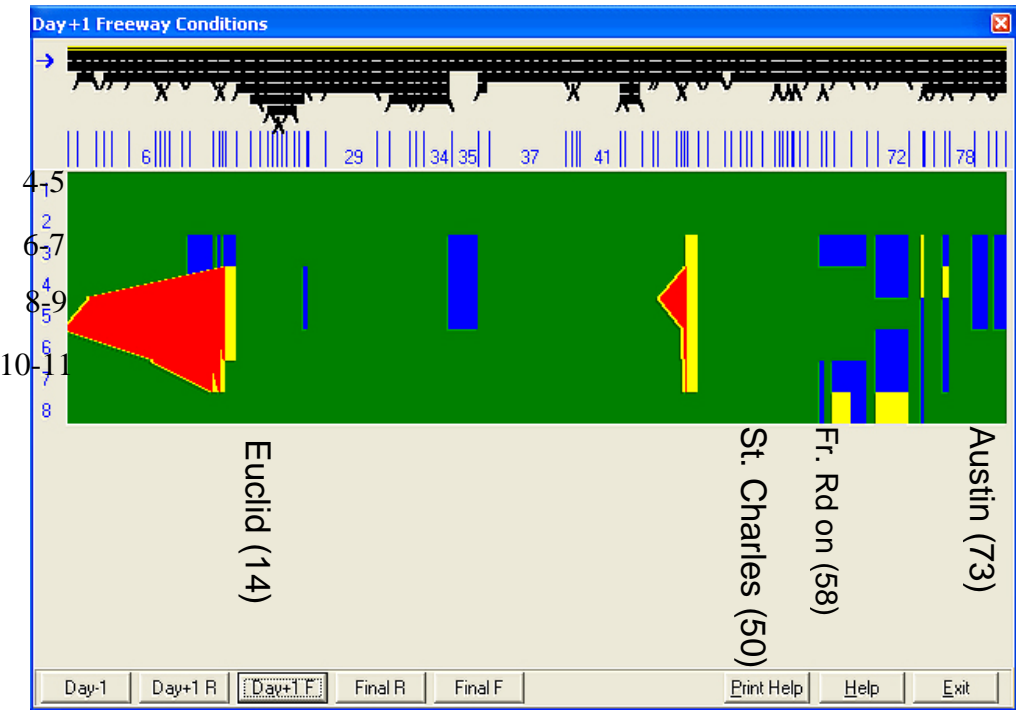


Figure 3. 2030 with Ramp Meters with Spatial Shift - Inbound AM

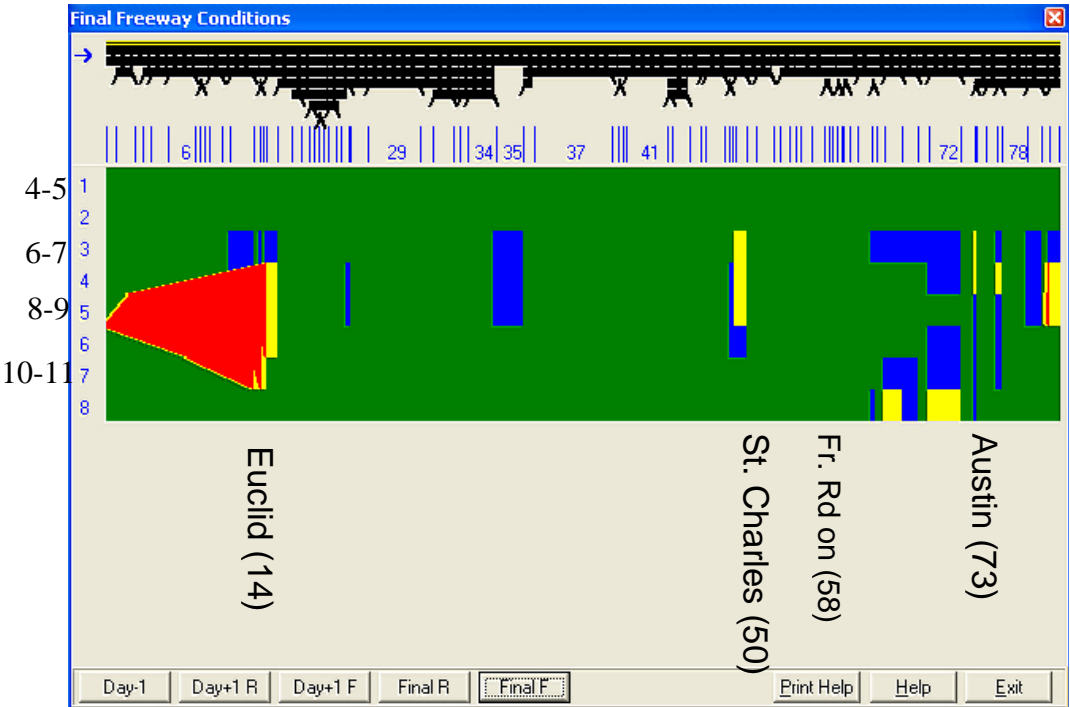


Figure 4. 2030 with Ramp Meters with PE with Spatial Shift - Inbound AM

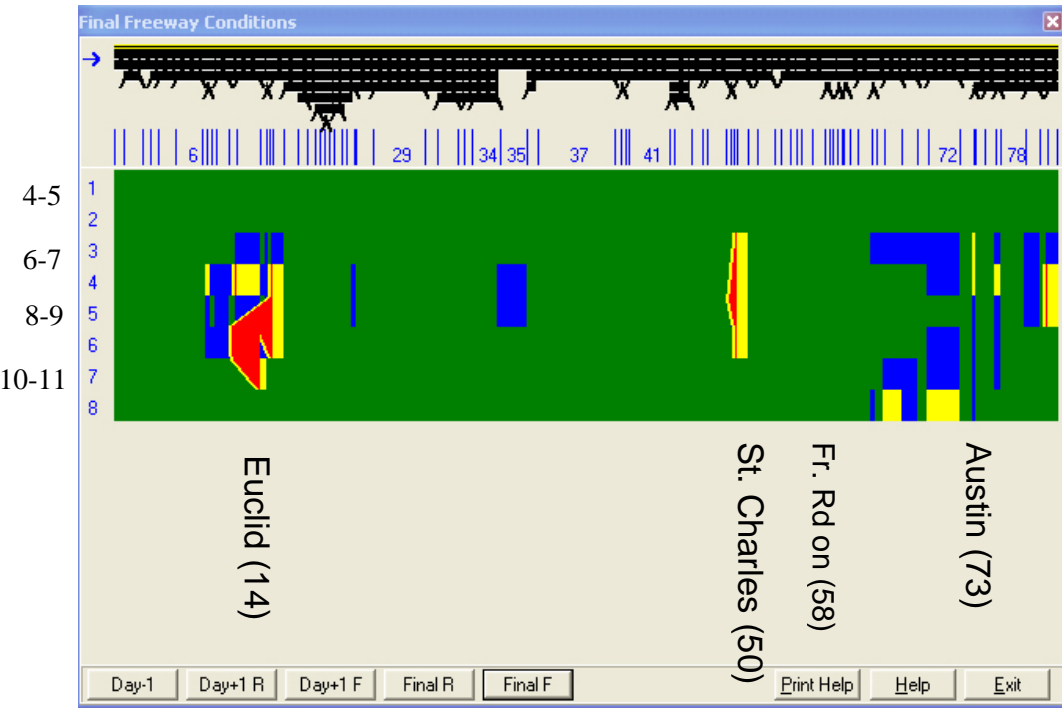


Figure 5. 2030 with Ramp Meters with PE with Spatial and Mode Shift - Inbound AM

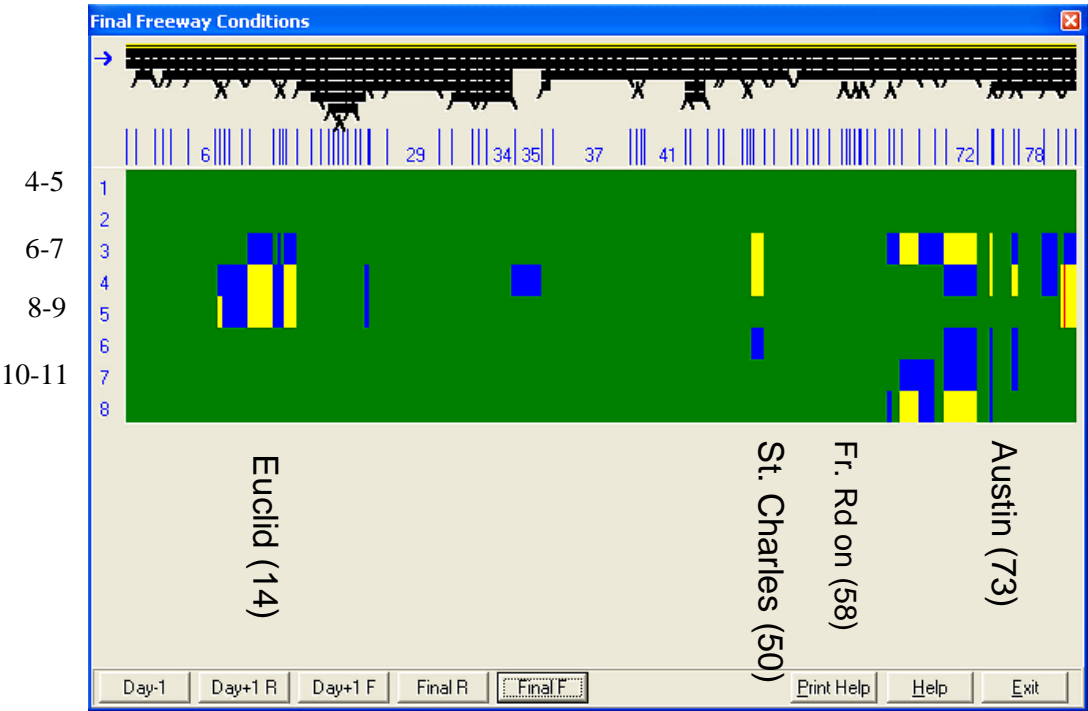
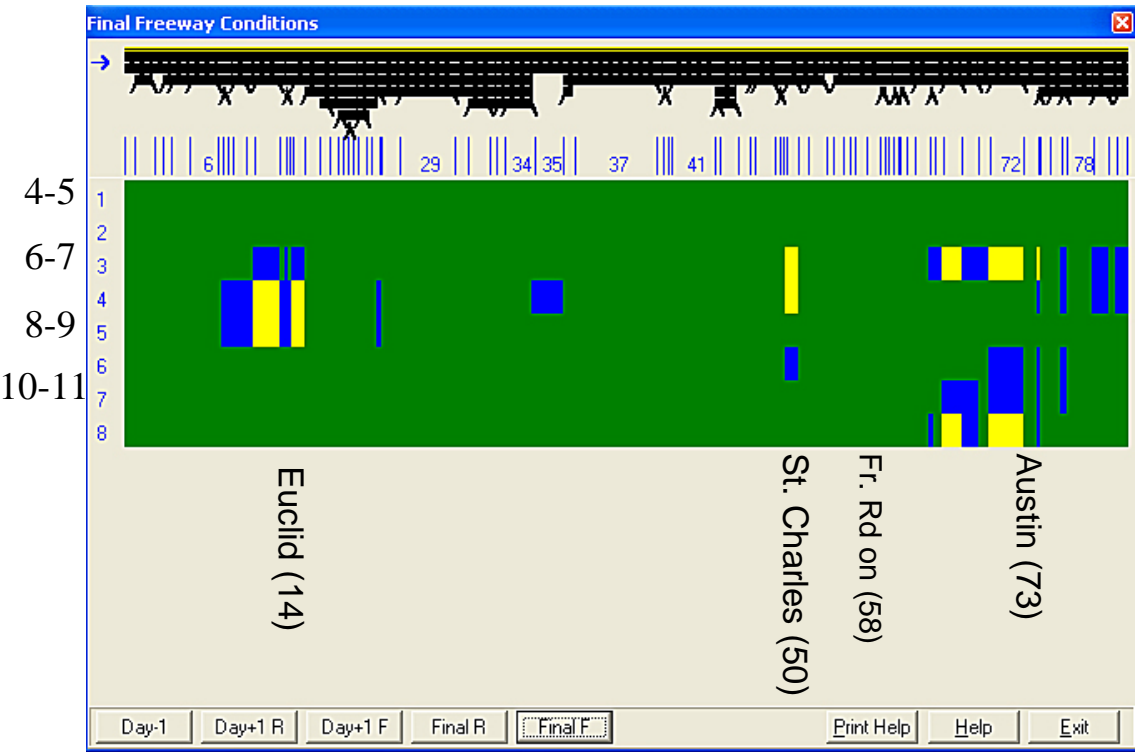


Figure 6. 2030 with Ramp Meters with PE with Spatial and Mode Shift, with Bus Service ---Inbound AM



Inbound PM

Figure 7. 2030 Base Condition - Inbound PM

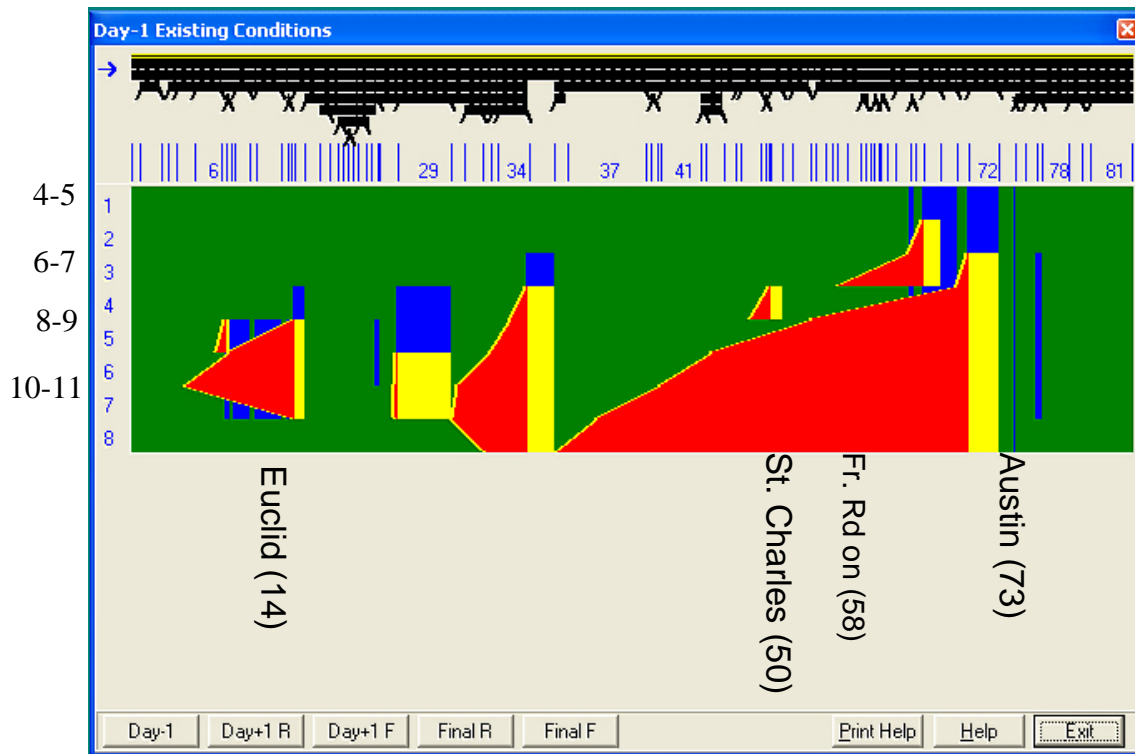


Figure 8. 2030 with Ramp Meters without Spatial Shift - Inbound PM

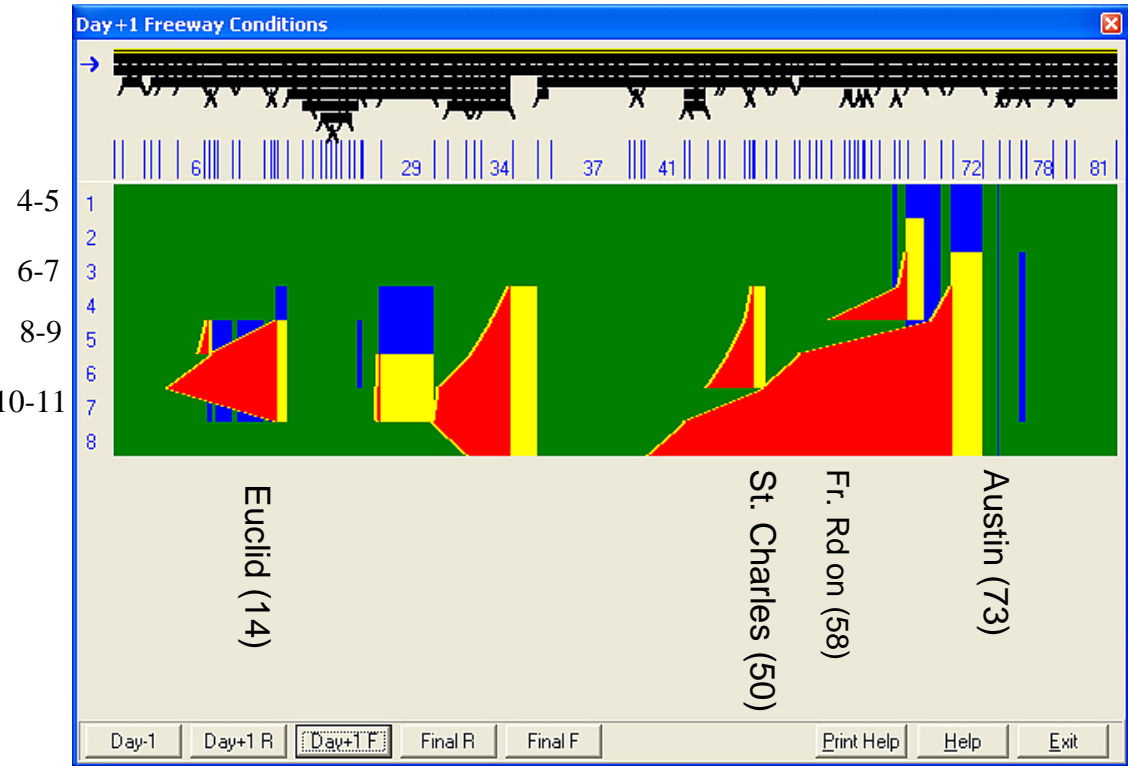


Figure 9. 2030 with Ramp Meters with Spatial Shift - Inbound PM

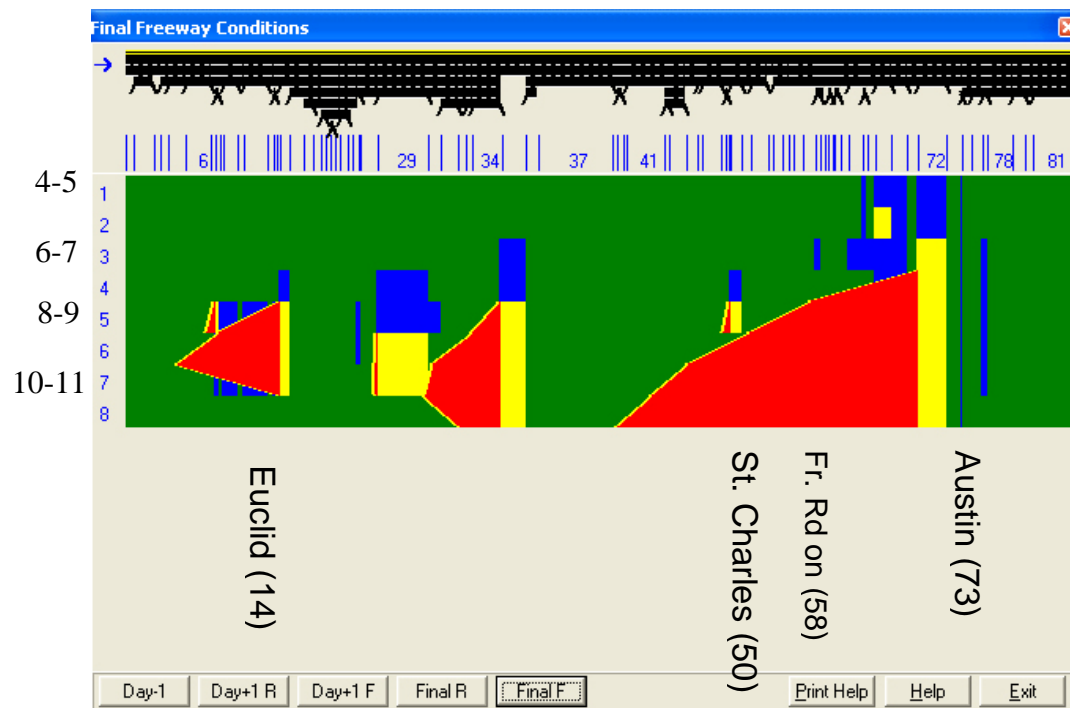


Figure 10. 2030 with Ramp Meters with PE with Spatial Shift - Inbound PM

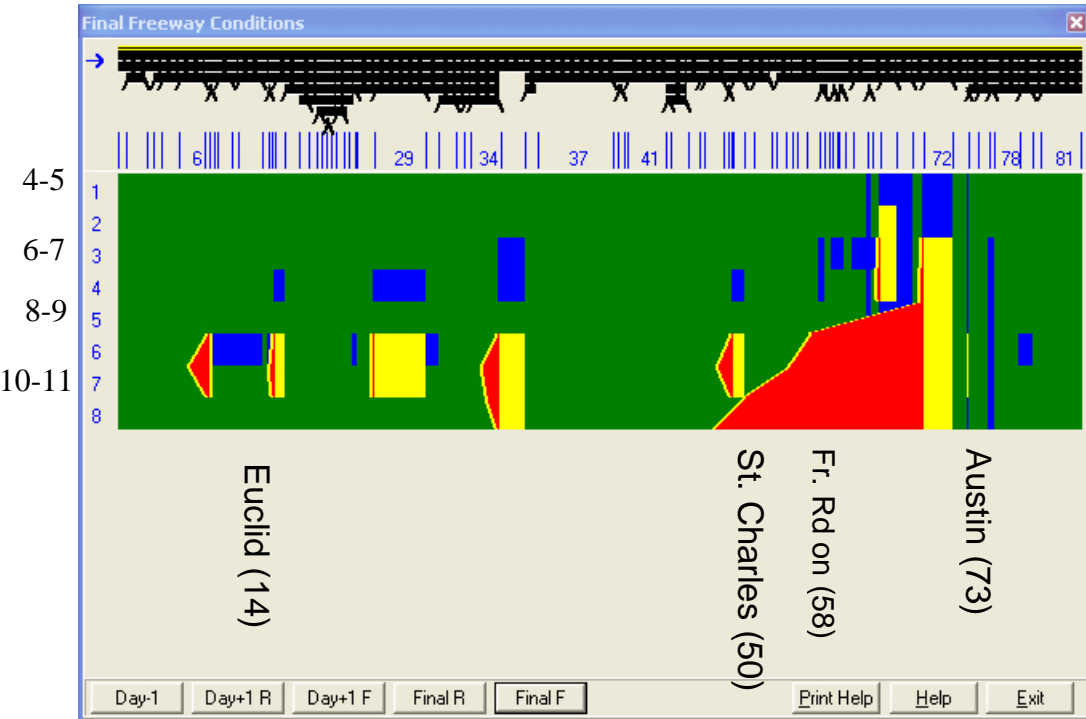


Figure 11. 2030 with Ramp Meters with PE with Spatial and Mode Shifts- Inbound PM

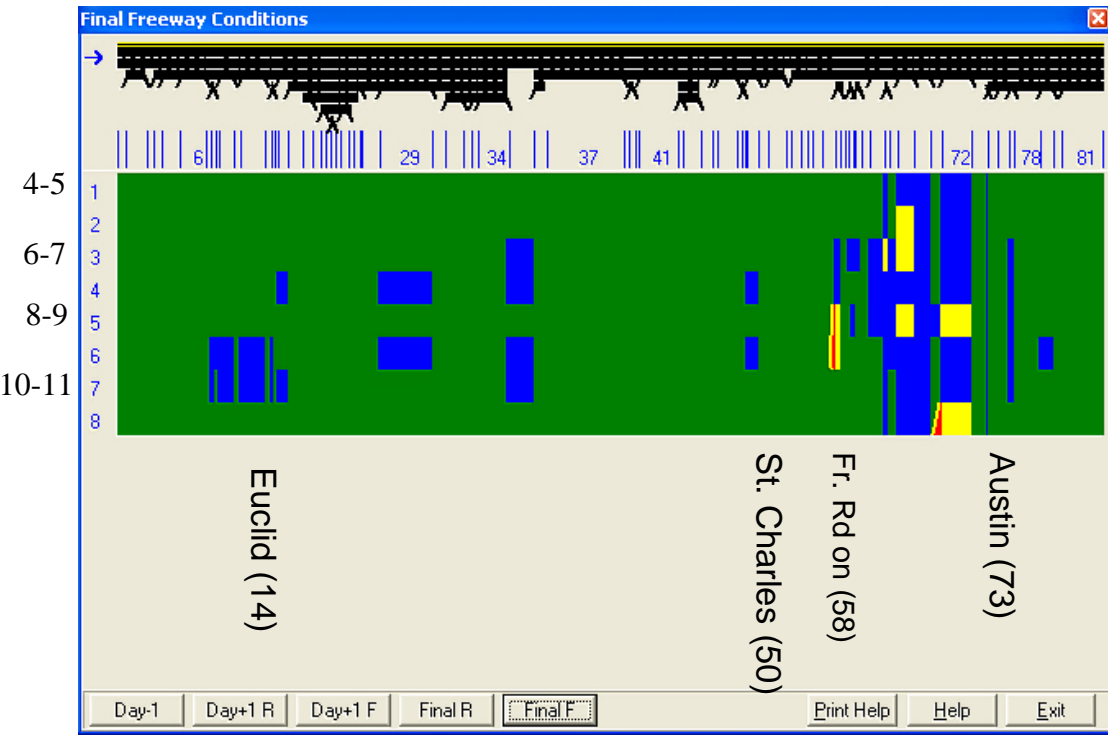
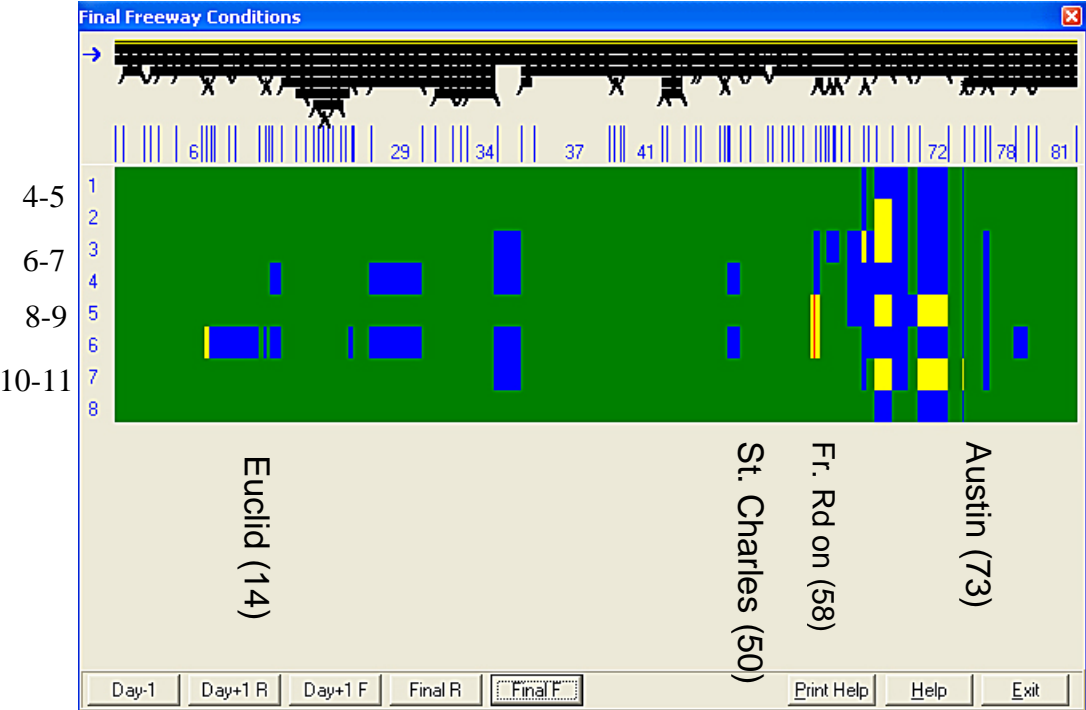


Figure 12. 2030 with Ramp Meters with PE with Spatial and Mode Shift, with Bus Service ---
Inbound PM



Outbound AM

Figure 13. 2030 Base Condition - Outbound AM

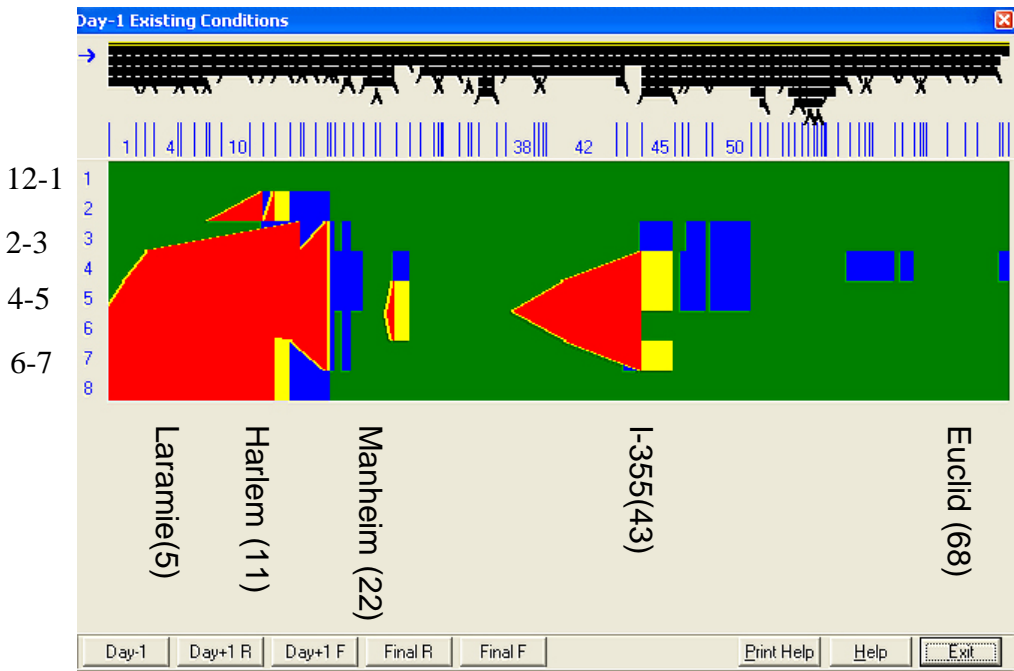


Figure 264. 2030 with Ramp Meters without Spatial Shift - Outbound AM

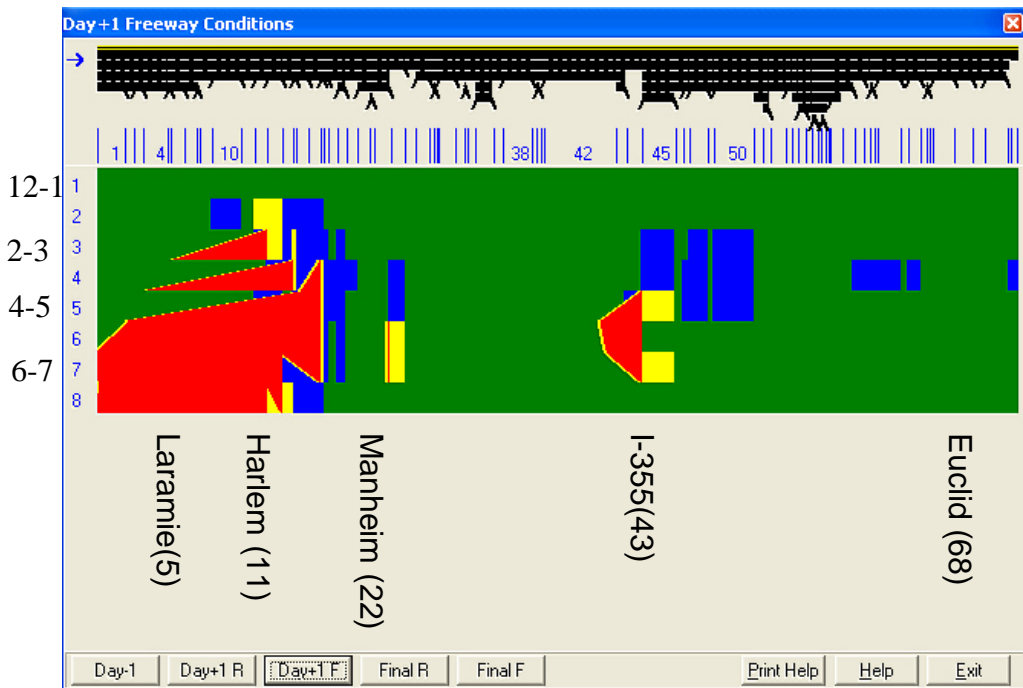


Figure 15. 2030 with Ramp Meters with Spatial Shift - Outbound AM

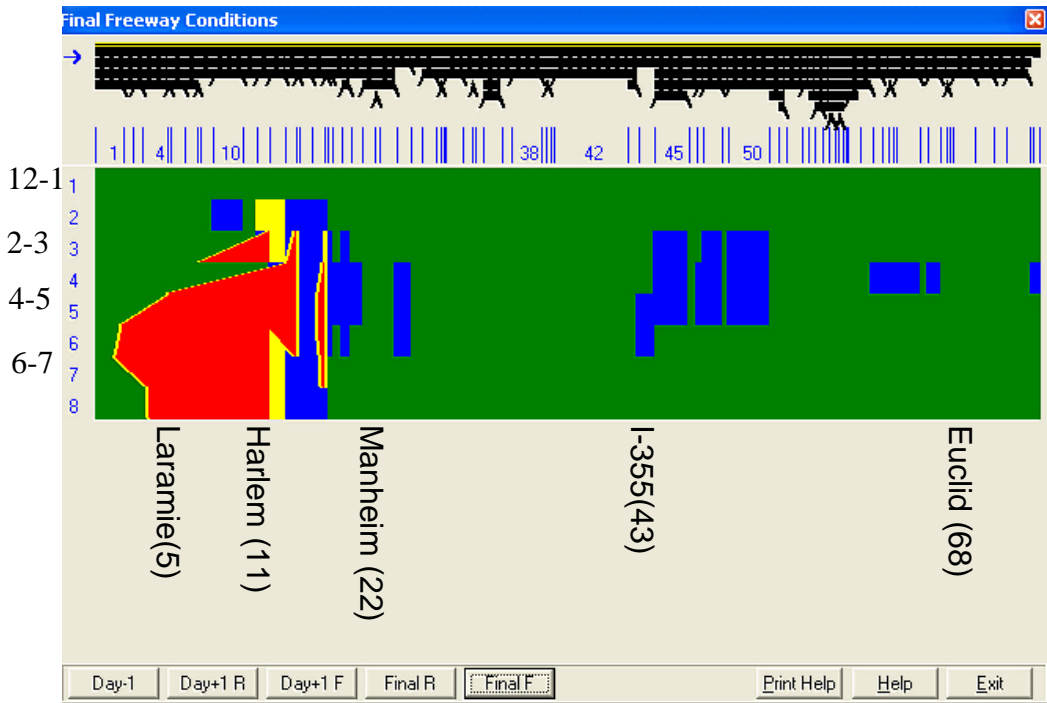


Figure 16. 2030 with Ramp Meters with PE with Spatial Shift - Outbound AM

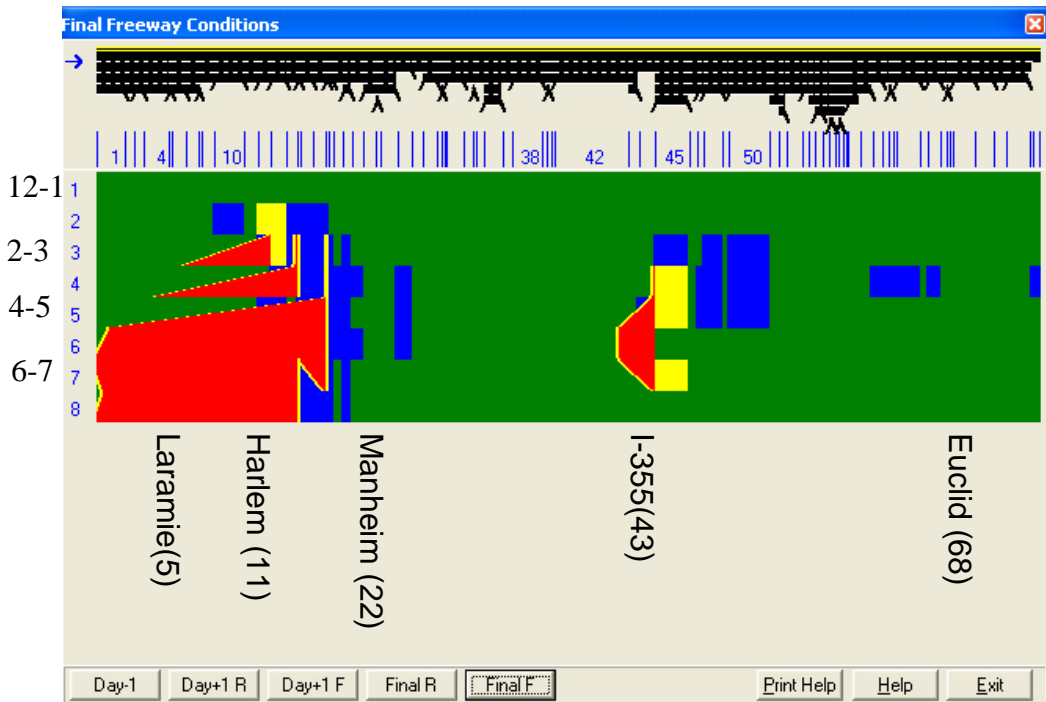


Figure 17. 2030 with Ramp Meters with PE with Spatial and Mode Shift - Outbound AM

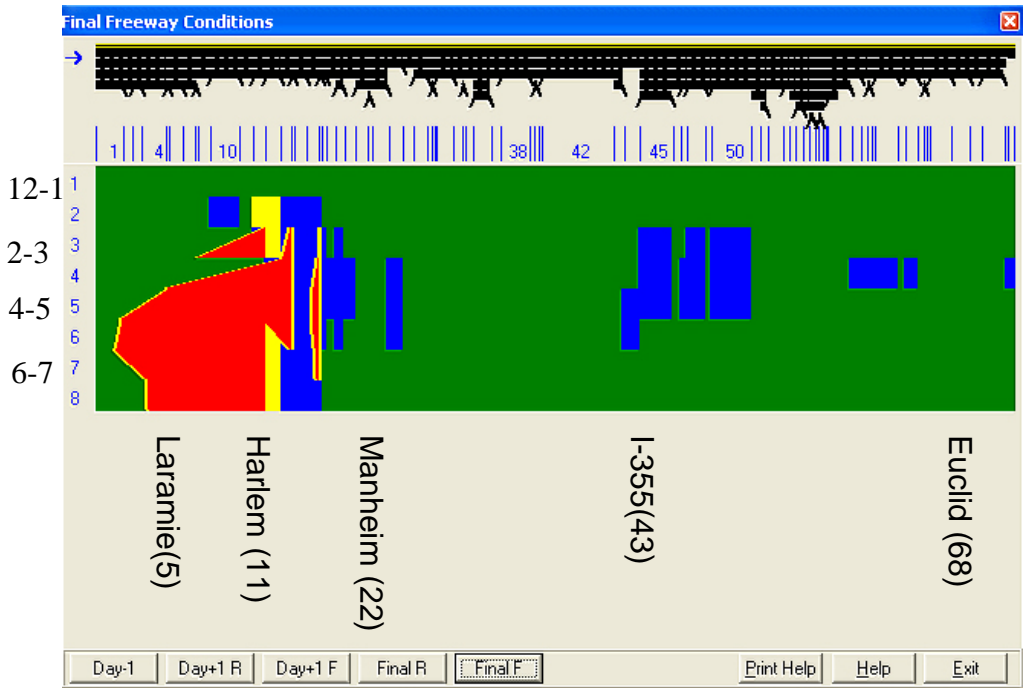
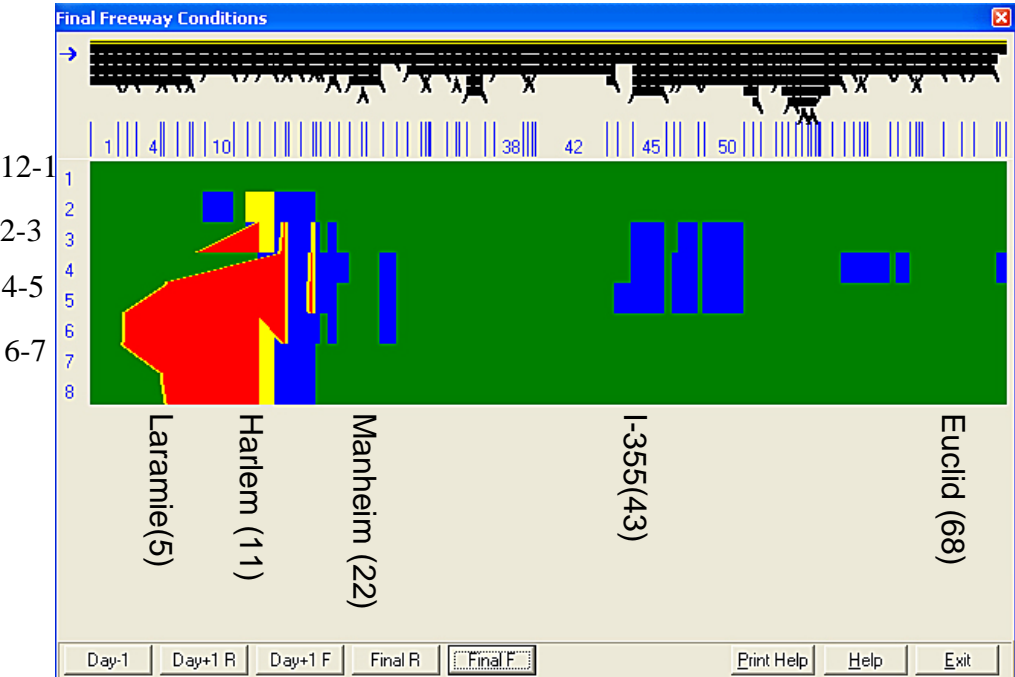


Figure 18. 2030 with Ramp Meters with PE with Spatial and Mode Shift, with Bus Service --- Outbound AM



Outbound PM

Figure 19. 2030 Base Condition - Outbound PM

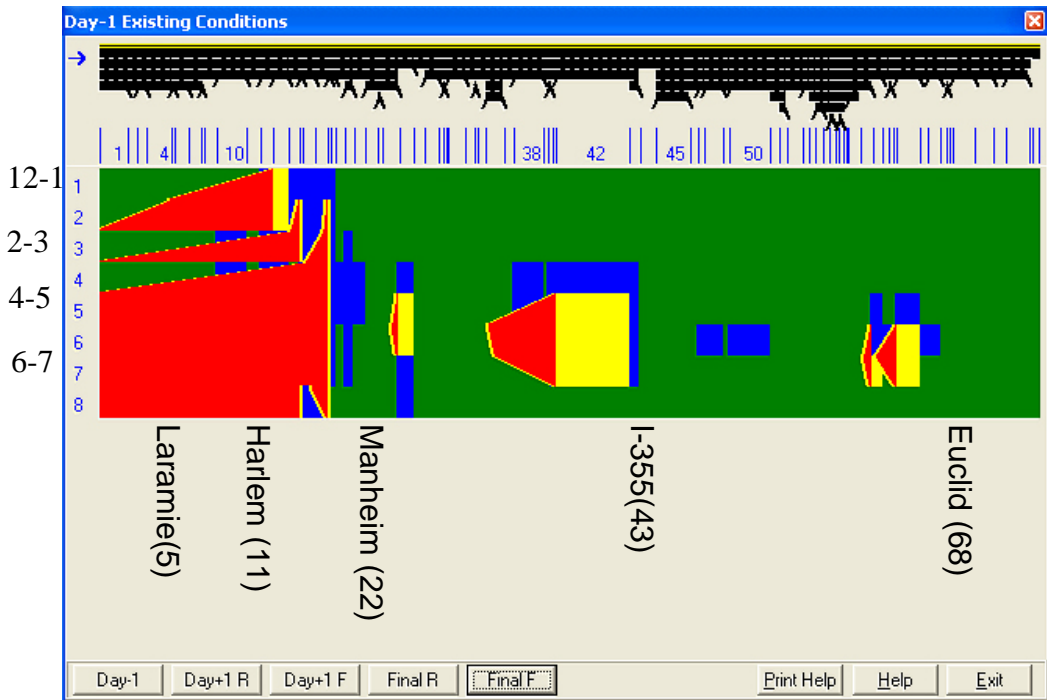


Figure 20. 2030 with Ramp Meters without Spatial Shift - Outbound PM

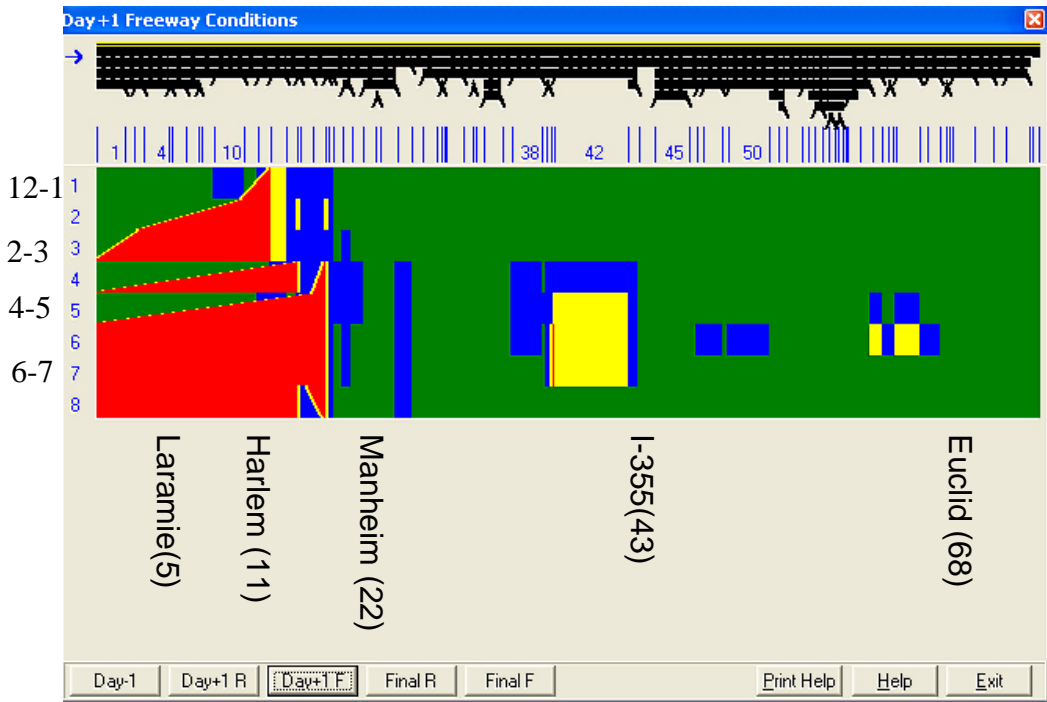


Figure 21. 2030 with Ramp Meters with Spatial Shift - Outbound PM

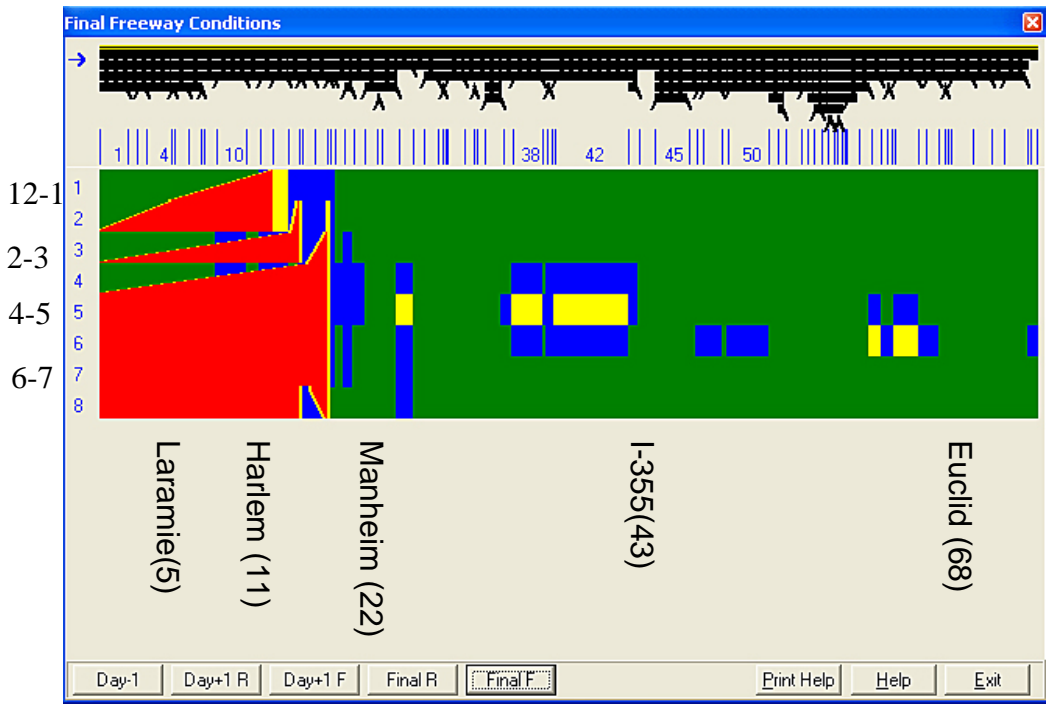


Figure 22. 2030 with Ramp Meters with PE with Spatial Shift - Outbound PM

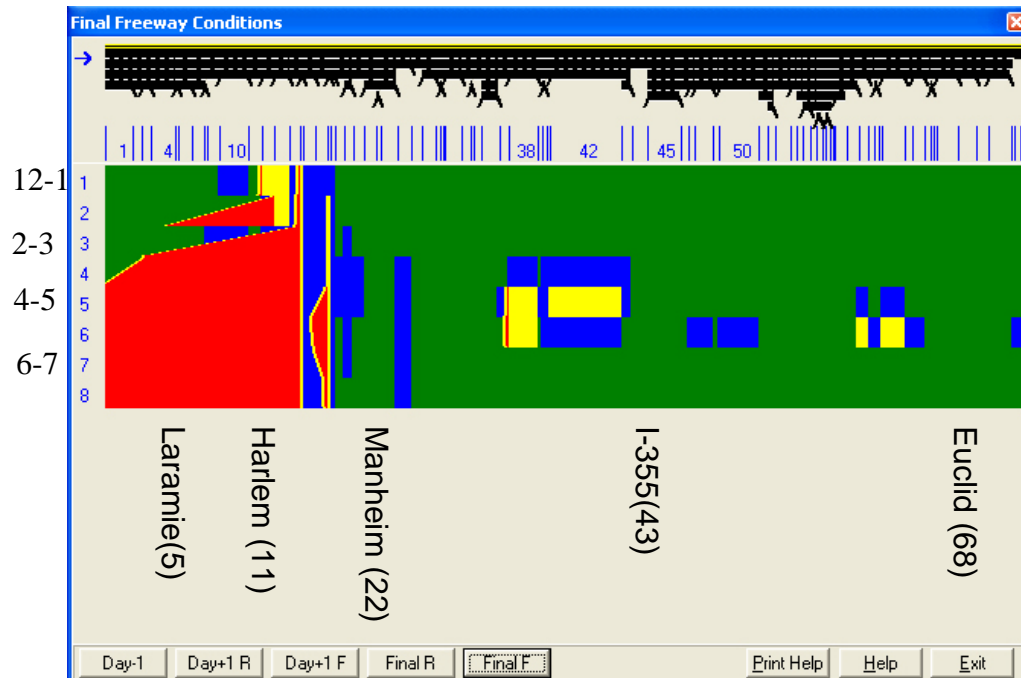


Figure 23. 2030 with Ramp Meters with PE with Spatial and Mode Shift - Outbound PM

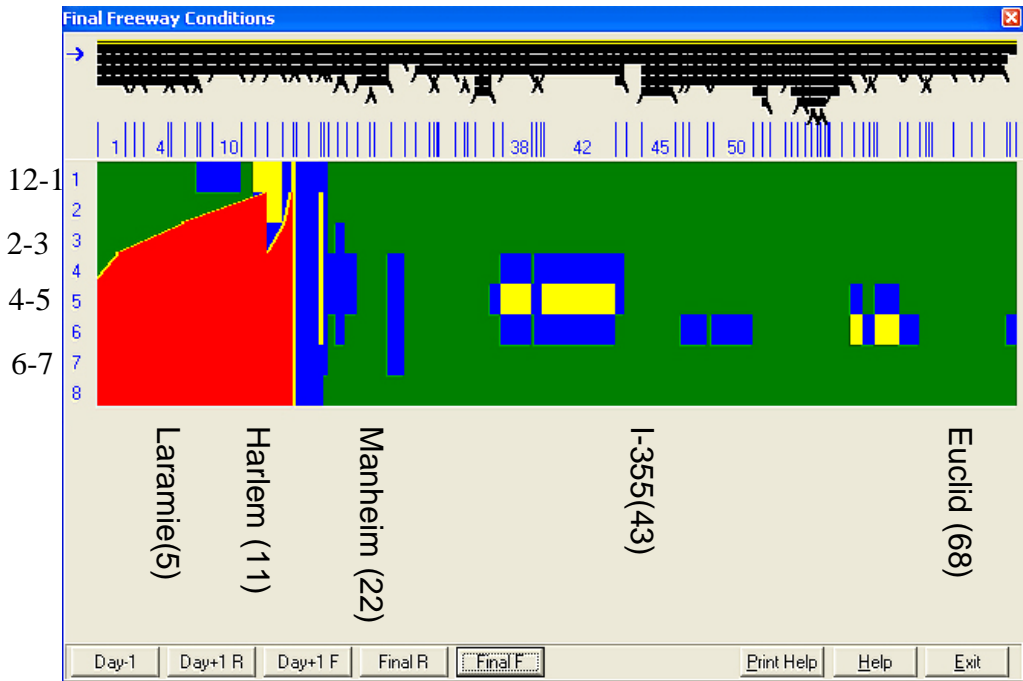


Figure 24. 2030 with Ramp Meters with PE with Spatial and Mode Shift, with Bus Service ---
Outbound PM

